PROJECT ONE: MILESTONE 3A – COVER PAGE

Team Number: TUES-24

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

Full Name:	MacID:
Yasmine Elkhouly	Elkhouy
Borna Sadeghi	sadegb1
Taaha Atif	AtifT
Pritika Thevakanthan	thevakap

MILESTONE 3A (STAGE 1) – MATERIAL SELECTION: PROBLEM DEFINITION

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1. Copy-and-paste the title of your *assigned* scenario in the space below.

Scenario 4 – A Pioneer in Clean Energy

2. MPI selection
   - List one primary objective and one secondary objective in the table below
   - For each objective, list the MPI
   - Write a short justification for your selected objectives

	Objective	MPI-stiffness	MPI-strength	Justification for this objective
Primary	Minimize Mass	E/ρ	σ_y/ρ	With heavier blades, more wind is needed to turn the rotor, therefore lighter blades are easier to turn, and hence more efficient in capturing energy. Reductions in mass also lead to reductions in fatigue loads for large wind turbines, which increases the lifespan and reduces maintenance requirements of a wind turbine.
Secondary	Minimize Cost	E/C_m	$\sigma_y/C_m\rho$	Since many units of this turbine are required, and the project has a large scale, production and installation of wind turbines for the wind farm will be highly expensive. Taking an incremental approach to making the process as cost-efficient as possible means that the cost of the blade itself relative to the cost that it offsets through energy production will need to be minimized.

MILESTONE 3A (STAGE 2) – MATERIAL SELECTION: MPI AND MATERIAL RANKING

Document the results of your materials selection and ranking on the following page.

→ Each team member is required to complete this on the *INDIVIDUAL* worksheet document, and then copy-and-paste to this document

We are asking that you submit your work on both worksheets**.** It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their summary of material property charts with the **Milestone Three-A Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Three-A Team Worksheets** document allows you to readily access your team member's work
    - This will be especially helpful when completing ***Stage 3*** of the milestone

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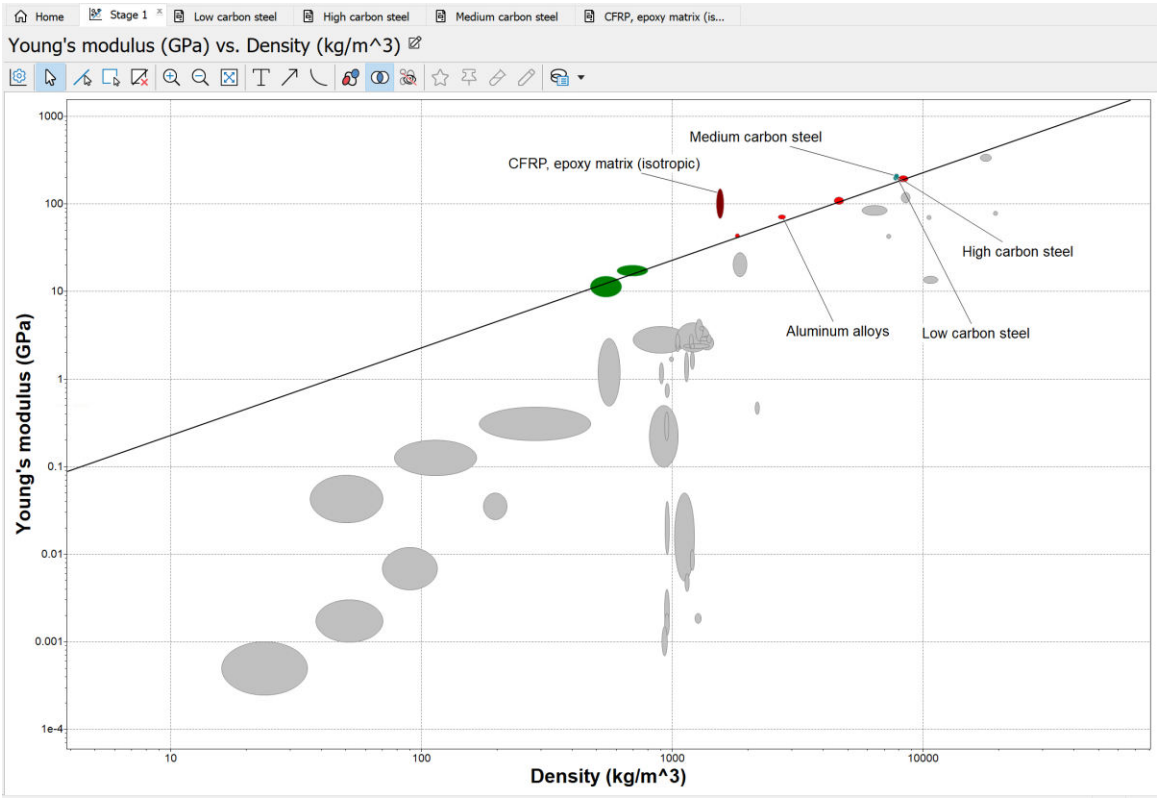
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Yasmine Elkhouly	Elkhouy

Material Property Chart		
Assigned MPI #1	**Functional Constraint**	**Objective**
/ ρ	d<d*	Minimize Mass

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their name in the plot.



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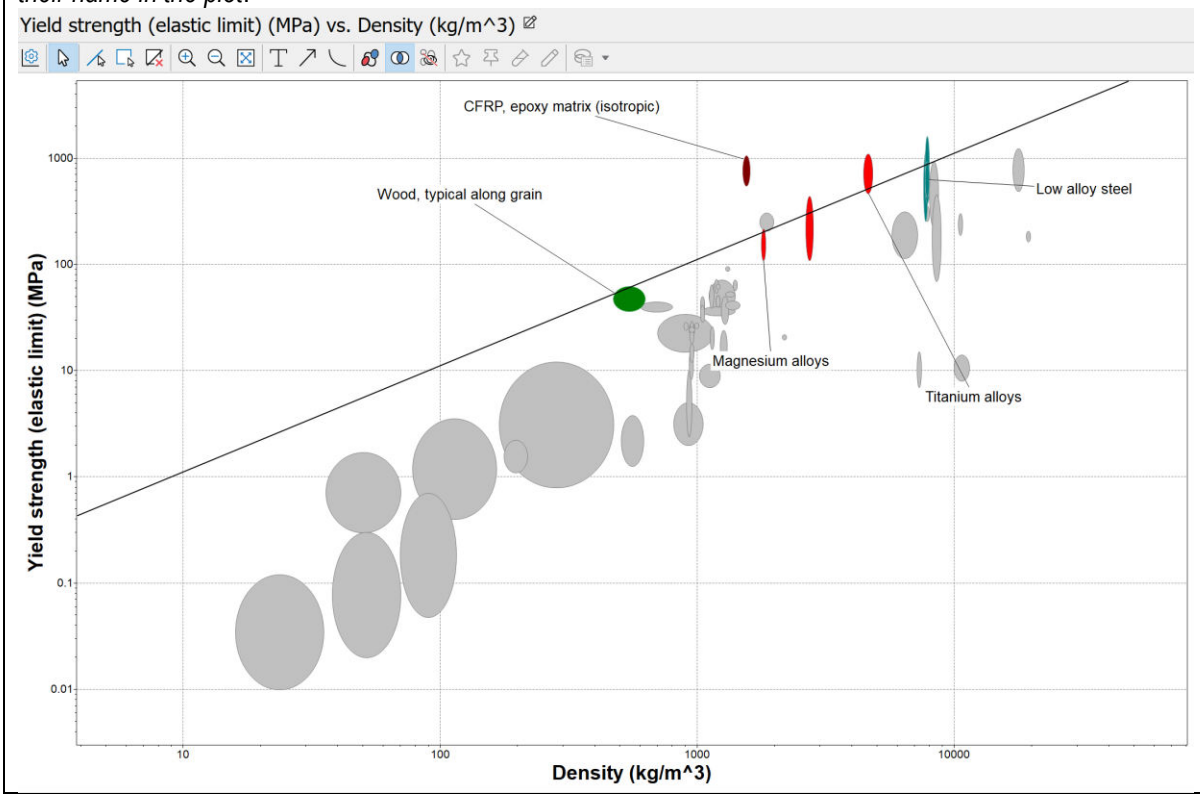
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Taaha Atif	AtifT

Material Property Chart

Assigned MPI #2	Functional Constraint	Objective
/ ρ	d< d*	Minimize Mass

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their name in the plot.



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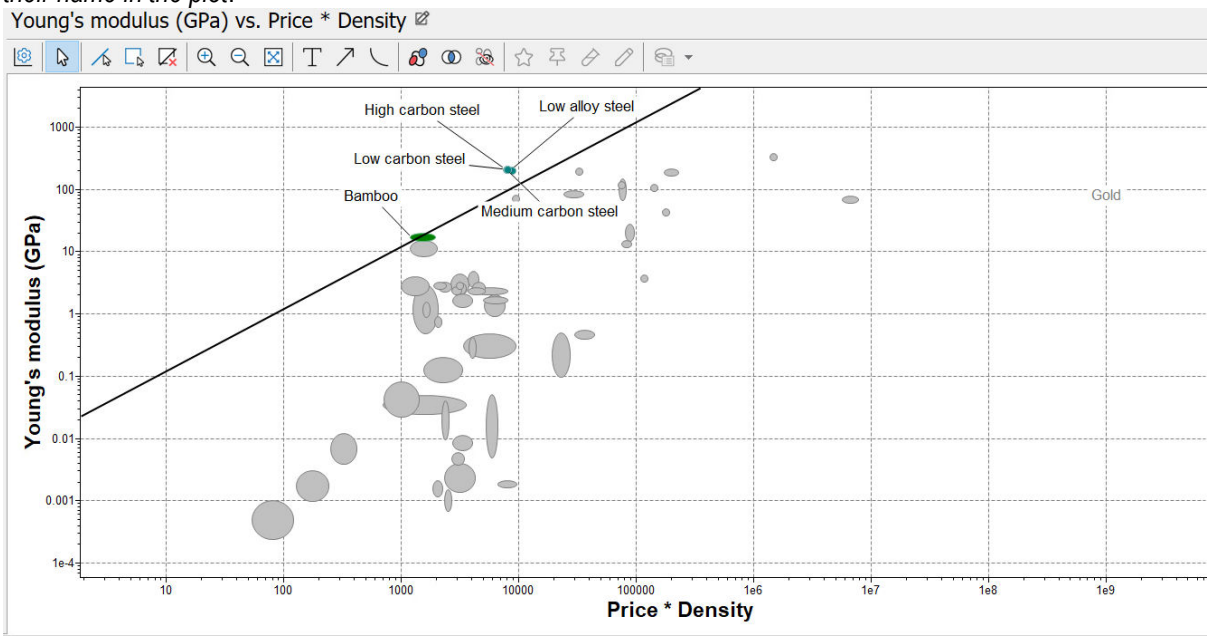
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Pritika Thevakanthan	thevakap

Material Property Chart

Assigned MPI #3	Functional Constraint	Objective
□/□m	d<d*	Minimize Cost

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their name in the plot.



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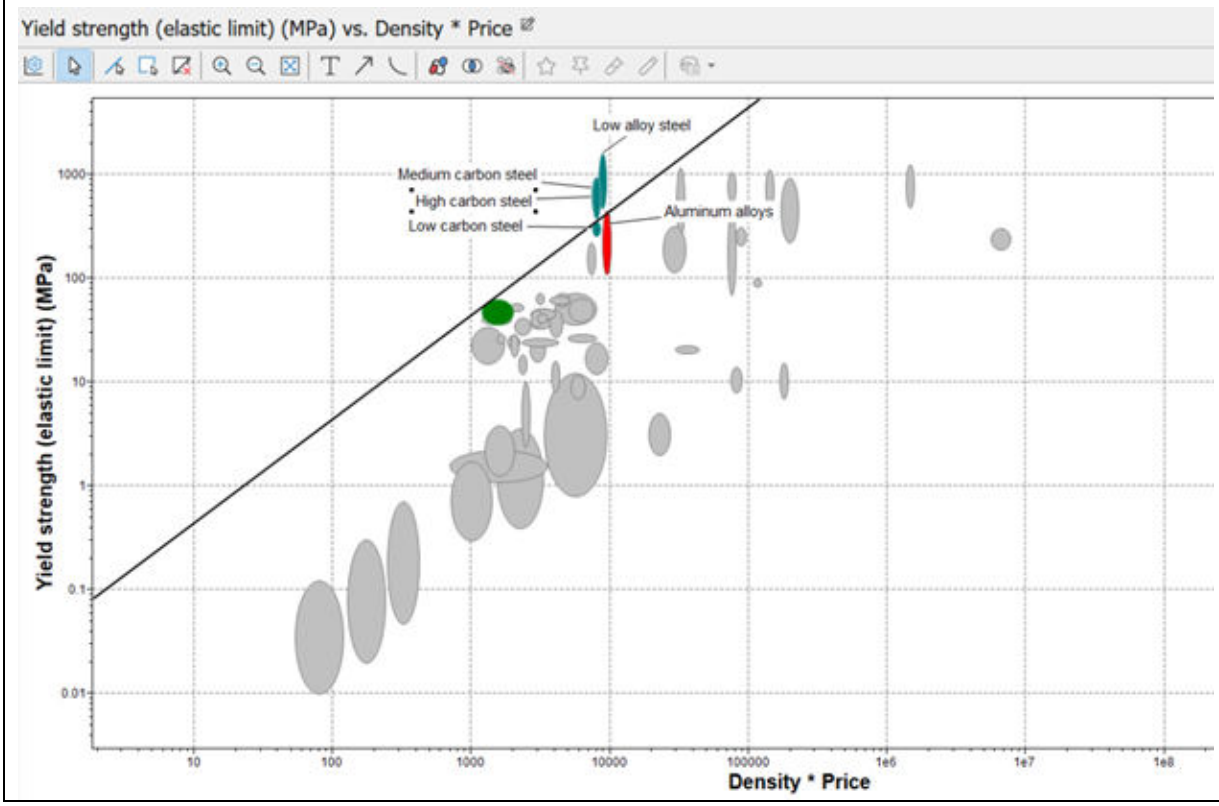
Copy-and-paste from the INDIVIDUAL worksheet

Full Name:	MacID:
Borna Sadeghi	sadegb1

Material Property Chart		
Assigned MPI #4	**Functional Constraint**	**Objective**
□/ □m ρ	d<d*	Minimize Cost

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their name in the plot.



MILESTONE 3A (STAGE 3) – MATERIAL SELECTION: MATERIAL ALTERNATIVES AND FINAL SELECTION

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Consolidation of Individual Material Rankings					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
	Material Name	Material Name	Material Name	Material Name	Material Name
MPI 1	**CFRP, Epoxy Matrix (Isotropic)**	**Medium Carbon Steel**	**High Carbon Steel**	Low Carbon Steel	Aluminum Alloys
MPI 2	**CFRP, Epoxy Matrix (Isotropic)**	Titanium Alloys	GFRP, epoxy matrix (isotropic)	Low alloy Steel	Aluminum alloys
MPI 3	**High Carbon Steel**	**Medium Carbon Steel**	Low Carbon Steel	Low Alloy Steel	Bamboo
MPI 4	Low alloy steel	**High carbon steel**	**Medium carbon steel**	Low carbon steel	Wood, typical along grain

Narrowing Material Candidate List to 3 Finalists	
Material Finalist 1:	High carbon steel
Material Finalist 2:	Medium carbon steel
Material Finalist 3:	CFRP, Epoxy Matrix (Isotropic)

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Compare Material Alternatives and Make a Final Selection using a Decision Matrix

→ As a team, establish a weighting factor for each criterion:

- Move row-by-row
  - If *Criteria 1* is preferred over *Criteria 2*, assign a 1. Otherwise, assign 0
  - If *Criteria 1* is preferred over *Criteria 3*, assign a 1. Otherwise, assign 0
- Add additional rows/columns as needed

Criteria Ranking								
0: top is more important, 1: left is more important	*Lightweight*	*Yield Strength*	*Durability/Fatigue Strength*	Stiffness (Resistance to deflection)	Affordability	Ecological footprint	Availability	**Weight factor**
Lightweight	1	0	0	0	1	1	1	4
Yield Strength	1	1	1	1	1	1	1	7
Durability/ Fatigue Strength	1	0	1	1	1	1	1	6
Stiffness	1	0	0	1	0	1	1	4
Affordability	0	0	0	0	1	0	0	1
Ecological footprint	0	0	0	0	1	1	0	2
Availability	0	0	0	0	1	1	1	3

→ As a team, evaluate your materials against each criterion using your weighting

- Add additional rows as needed

Decision Matrix				
	Weight	*High carbon steel*	*Medium carbon steel*	CFRP, Epoxy Matrix

	factor					(Isotropic)	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Lightweight	4	3	**12**	3	**12**	5	**20**
Yield Strength	7	4	**28**	3	**21**	5	**35**
Durability	6	4	**24**	3	**18**	5	**30**
Stiffness	4	3	**12**	3	**12**	5	**20**
Affordability	1	5	**5**	5	**5**	1	**1**
Ecological footprint	2	5	**10**	5	**10**	1	**2**
Availability	3	4	**12**	4	**12**	2	**6**
TOTAL			**103**		**90**		**114**

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→ List your chosen material and justify your selection

Justification	
List Chosen Material:	CFRP, Epoxy Matrix (Isotropic)
Carbon fiber is a very popular material for applications that require both strength and light weight. In order to build a wind turbine, we want to make the blades as light as possible, and carbon fiber beats out both high carbon and medium carbon steels by far as the lightest material (Carbon fiber is approximately one-fifth the density of the steels). We also want our wind turbine to possess a high yield strength, durability and stiffness, in order to minimize damage from chronic and acute shock and weather conditions, while maximizing the conversion of kinetic energy into mechanical energy to be used for power generation. In terms of yield strength, carbon fiber can withstand about two times more force per unit area, making it tough to break in the presence of extreme weather conditions. Although carbon fiber is relatively less affordable, available, and ecologically friendly, these factors are considered on a one-time basis (initial costs and environmental damage in materials processing). In the long run, the carbon fiber blade should prove more effective and eventually offset the initial damages and prices that are caused by the creation and implementation of the material.	

Summary of Chosen Material's Properties

Material Name: CFRP, Epoxy Matrix (Isotropic)	Average value:
Young's modulus E (GPa):	110
Yield Strength σ_y (MPa):	800
Tensile strength σ_{UTS} (MPa):	800
Density ρ (kg/m^3):	1550
Embodiment Energy H_m (MJ/kg)	689
Specific carbon footprint CO_2 (kg/kg)	48.2