

## Milestone 3 (Team) – Cover Page

Team Number:

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

<b>Full Name:</b>	<b>MacID:</b>
Eloise Nguyen	Nguyt126
Sohail Persaud	persas29
Rory Sucharov-Gluck	sucharor
Hassan Bokhari	bokharh

Any student that is **not** present for Design Studio will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their DP-2 grade.

## MILESTONE 3 (STAGE 2) – PRELIMINARY DESIGN ANALYSIS FRACTURE RISK

Team Number: 26

Calculate the fracture risk of the implant stem assuming a combined loading scenario. Don't forget to:

- Compare tensile stress on the lateral side of the implant to the ultimate tensile strength of your assigned material
- Show all of your work neatly and in detail (do not skip steps), include the correct number of significant digits, and correct units

The whiteboard shows the following calculations:

$$FR = \frac{\sum \text{total, tension}}{UTS \text{ implant}}$$
$$\Sigma A = \frac{F}{A} = \frac{3.5 \times 103.5 \text{ Kg} \times 9.81 \text{ m/s}^2}{\frac{\pi}{4} (0.5 \times 19 \text{ mm})^2} = \frac{3553.6725 \text{ N}}{70.8822 \text{ mm}^2} = 50.13 \text{ MPa}$$
$$\Sigma B = \frac{My}{I} = \frac{(F \times L)(0.5 \times d)}{\frac{\pi}{64} d^4}$$
$$= \frac{(3553.6725 \text{ N} \times 51 \text{ mm})(0.5 \times (0.5 \times 19 \text{ mm}))}{\frac{\pi}{64} \times (0.5 \times 19 \text{ mm})^4}$$
$$= 2153.16 \text{ MPa}$$
$$FR = \frac{(50.13 \text{ MPa}) + (2153.16 \text{ MPa})}{950 \text{ MPa}} = 2.31$$

## MILESTONE 3 (STAGE 2) – PRELIMINARY DESIGN ANALYSIS FATIGUE LIFE

Team Number: 26

Calculate the fatigue life of your assigned material.

→ Show all of your work neatly and in detail (do not skip steps), include the correct number of significant digits, and correct units

The image shows handwritten calculations on a whiteboard. The calculations determine the stress amplitude, maximum and minimum stresses, and the resulting fatigue life. The final result, "Fatigue life = 10<sup>5.25</sup> cycles", is circled in pink.

$$\text{Stress Amplitude} = \frac{\Sigma_{\max} - \Sigma_{\min}}{2} = \frac{429.72 \text{ MPa} - (-429.72 \text{ MPa})}{2} = 429.72 \text{ MPa}$$
$$F_{\max} = (103.5)(9.81)(30) = 30\,460.05 \text{ N}$$
$$\Sigma_{\max} = \frac{F_{\max}}{A} = \frac{30\,460.05 \text{ N}}{70.8822 \text{ mm}^2} = 429.72 \text{ MPa}$$
$$F_{\min} = -(103.5)(9.81)(30) = -30\,460.05 \text{ N}$$
$$\Sigma_{\min} = \frac{-30\,460.05 \text{ N}}{70.8822 \text{ mm}^2} = -429.72 \text{ MPa}$$

Looking at S-N curve,  
Fatigue life = 10<sup>5.25</sup> cycles

## MILESTONE 3 (STAGE 2) – PRELIMINARY DESIGN ANALYSIS

### BONE STRESS REDUCTION

Team Number: 26

Calculate the magnitude of bone stress reduction after implant reconstruction. Don't forget:

- Calculations should not consider a combined loading scenario, like in Part 1 of this Milestone
- Show all of your work neatly and in detail (do not skip steps), include the correct number of significant digits, and correct units

Handwritten calculations on a whiteboard:

$$\sigma_{\text{reduc}} = \sigma_{\text{comp}} \cdot \left( \frac{2 \cdot E_{\text{bone}}}{E_{\text{bone}} + E_{\text{implant}}} \right)^{\frac{1}{2}}$$
$$= \frac{F}{A} \cdot \left( \frac{2 \cdot E_{\text{bone}}}{E_{\text{bone}} + E_{\text{implant}}} \right)^{\frac{1}{2}}$$

(from previous question)

$$= \frac{30,460.05 \text{ N}}{678.58 \text{ mm}^2} \cdot \left( \frac{2 \cdot 17 \text{ GPa}}{17 \text{ GPa} + 114 \text{ GPa}} \right)^{\frac{1}{2}}$$
$$\sigma_{\text{reduc}} = 22.9 \text{ MPa}$$
$$A = \frac{\pi}{4} (D_o^2 - D_i^2)$$
$$= \frac{\pi}{4} (35^2 - 19^2 \text{ mm}^2)$$
$$= 678.58 \text{ mm}^2$$