Milestone 3 (Team) – Cover Page

Team Number: 6

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

Full Name:	MacID:
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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: 6

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

$$A_{implant} = \frac{1}{4}\pi d^2 \Big|_{d=19mm}$$

$$= \frac{1}{4}\pi\left(\frac{19}{2}\right)^2$$

$$= \frac{361}{16}\pi\, mm^2$$

$$F = 3.5 \times 103.5kg \cdot 9.81\, m/s^2$$

$$= 3,553.6725N$$

$$\sigma_q = \frac{F}{A}$$

$$= \frac{3,553.6725N}{\frac{361}{16}\pi\, mm^2}$$

$$= 50.135\, N/mm^2$$

$$y = 0.5 \cdot d$$

$$= \frac{19}{4}mm$$

$$M = F \cdot L$$

$$= 3,553.6725N \cdot 51mm$$

$$= 181237.2675\, N\,mm$$

$$I = \frac{\pi}{64} \cdot d^4$$

$$= \frac{\pi}{64}\left(\frac{19}{2}\right)^4$$

$$= \frac{130321}{1024}\pi\, mm^4$$

$$\sigma_B = \frac{M \cdot y}{I}$$

$$= 2153.162797$$

$$FR = \frac{\sigma_{total}}{UTS_{implant}}$$

$$= \frac{\sigma_A + \sigma_B}{UTS_{implant}}$$

$$= \frac{50.135\,N/mm^2 + 2153.162747}{1010\ MPa}$$

$$= 2.1814\ldots$$

$$= 2.2 \quad (2\ S.f.)$$ ✓

MILESTONE 3 (STAGE 2) – PRELIMINARY DESIGN ANALYSIS

FATIGUE LIFE

Team Number: 6

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

$$\sigma_{max} = \frac{30 \cdot BW}{A}$$

$$= \frac{30 \cdot (103.5\,kg \cdot 9.8\,m/s^2)}{\frac{361}{16}\pi\,mm^2}$$

from #1

$$= 429.7278692\ N/mm^2$$

$$\sigma_{min} = -\sigma_{max}$$

$$= -429.7278692\ N/mm^2$$

$$\sigma_{amp} = \frac{\sigma_{max} - \sigma_{min}}{2}$$

$$= \frac{429.72... - (-429.72...)}{2}$$

$$= 429.72...$$

$$= 430\ N/mm^2 \text{ (to 2 s.f.)}$$

∴ fatigue life would be 7×10^7 cycles

MILESTONE 3 (STAGE 2) – PRELIMINARY DESIGN ANALYSIS
BONE STRESS REDUCTION

Team Number: 6

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

$F = BW \cdot 30$

$= 103.5\,kg \cdot 9.81\,m/s^2 \cdot 30$

$= 30460.05\,N$

$A = \frac{\pi}{4}(D_o^2 - D_i^2)$

$= \frac{\pi}{4}((35\,mm)^2 - (19\,mm)^2)$

$= 216\pi\,mm^2$

$\sigma_{comp} = \frac{F}{A}$

$= \frac{30460.05\,N}{216\pi\,mm^2}$

$= 44.88766226$

$\sigma_{reduce} = \sigma_{comp} \cdot \left(\frac{2 \cdot E_{bone}}{E_{bone} + E_{imp}}\right)^{\frac{1}{2}}$

$= 16.49\,N/mm^2$ (2 S.f.)