UNIVERSIDAD AUTONOMA DE OCCIDENTE

FACULTAD DE INGENIERÍA

PROGRAMA DE INGENIERÍA BIOMÉDICA

Diseño de Dispositivos Biomédicos

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NOMBRE:

COD:

Identify the 7 figures of your student ID in the following way: **ABCDEFG**. Use that key as data for this question:

1. A design has the following conditions: Yield Strength: 45 ± **C** kpsi, Applied Stress: 39 ± (**E+F+G**) kpsi. It is desired to reduce the current probability of failure. Only the following options are available: a) A material with a Yield Strength equal to 1.5 times the applied stress. b) An element with 1.5 times the original cross sectional area. Show which of the two options is the most adequate from a safety view.

2. An archwire for orthodontic brackets has a diameter of 0.3 mm. The free length between brackets is 20 mm, the applied activation force is 30 ±3.15 N. The archwire material is a Ti-Alloy with a yield strength of 450 MPa (SD=5% of the Yield Strength). The probability of failure for this condition is 1.6%. If you want to increase reliability to 99.99% or more, which one of the following strategies is the most feasible and why? A) Change the diameter of the archwire. B) Change the archwire material. Suppose the principal loads on the archwire are tensile. Table 4.1 shows the possible

materials for this application. Suppose SD=5% of the Yield Strength for all cases.

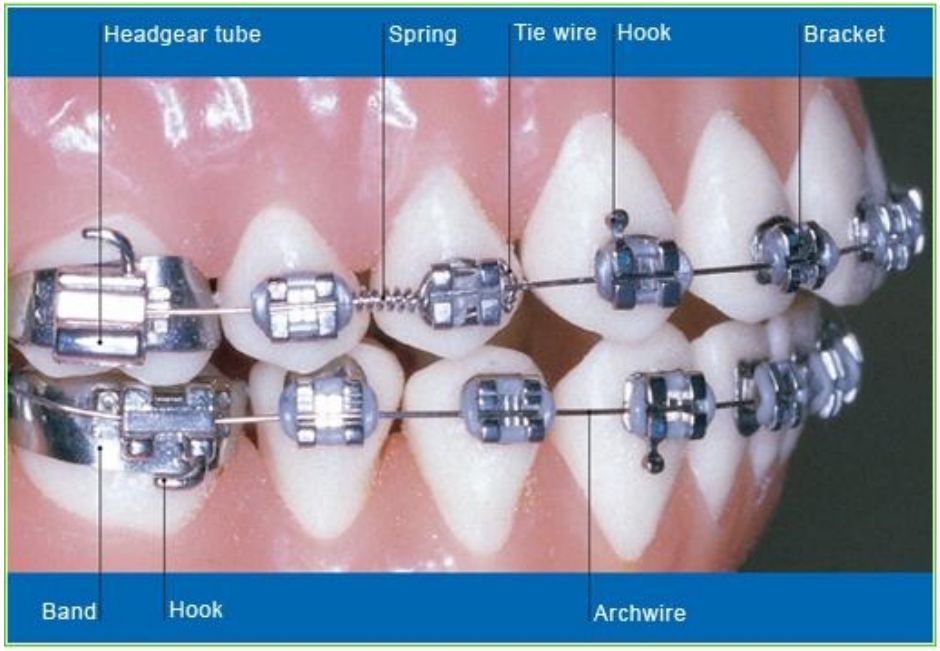

Table 4.1 Compositions and mechanical properties of the four major orthodontic wire alloy types

Wire Alloy	Composition (wt%)	Modulus of Elasticity (GPa)	Yield Strength (MPa)[a]	Springback[b]
Austenitic stainless steel	17–20% Cr, 8–12% Ni, 0.15% C (max), balance mainly Fe	160–180	1100–1500	0.0060–0.0094 (AR) 0.0065–0.0099 (HT)
Cobalt-chromium-nickel (Elgiloy Blue)	40% Co, 20% Cr, 15% Ni, 15.8% Fe, 7% Mo, 2% Mn, 0.15% C, 0.04% Be	160–190	830–1,000	0.0045–0.0065 (AR) 0.0054–0.0074 (HT)
β-titanium (TMA)	77.8% Ti, 11.3% Mo, 6.6% Zr, 4.3% Sn	62–69	690–970	0.0094–0.011
Nickel-titanium	55% Ni, 45% Ti (approx. and may contain small amounts of Cu or other elements)	34	210–410	0.0058–0.016

From Brantley, 1997.
[a]The values of yield strength correspond to 0.1% permanent tensile strain. [b]The terms AR and HT for the stainless steel and Elgiloy Blue alloys refer to the as-received and heat-treated conditions, respectively.