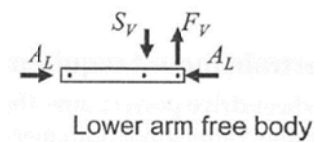
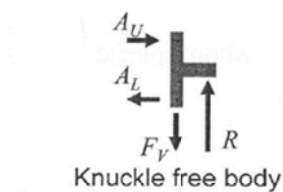


1. (2 pts each)

- | | |
|-------------------------------------|---------------------|
| (1) space frame | (2) body on frame |
| (3) body-frame integral (monocoque) | (4) compartment |
| (5) dash | (6) strut |
| (7) Mid rail | (8) frame |
| (9) panel | (10) joints |
| (11) brackets | (12) Spot weld |
| (13) shear | (14) dent |
| (15) shear | (16) peel |
| (17) yield | (18) plate buckling |
| (19) SS | (20) SS |

2. (3 pts each)



$$\sum F_x = 0 : A_U - A_L = 0 \rightarrow A_U = A_L$$

$$\sum F_y = 0 : S_V - A_V - R = 0 \rightarrow S_V = R + A_V$$

$$\sum M_{@lowerarm, F_V} = 0 : bA_V - (b - \lambda b)S_V = 0 \rightarrow A_V = (1 - \lambda)S_V$$

$$\rightarrow S_V = R + (1 - \lambda)S_V \rightarrow S_V = \frac{1}{\lambda} R$$

$$\sum M_{@knuckle, F_V} = 0 : eR - dA_U = 0 \rightarrow A_U = \frac{e}{d} R$$

$$A_L = A_U = \frac{e}{d} R$$

$$A_V = (1 - \lambda)S_V = (1 - \lambda)\frac{1}{\lambda}R = \left(\frac{1}{\lambda} - 1\right)R$$

3. (4 pts each)

Non-symmetrical nature of automotive beams

Local distortion of the section at the point of loading

Twisting of thin-walled members

Effect of spot welds on structural performance

4. (4 pts each) $\sigma_{cr} = k \underbrace{\frac{E\pi^2}{12(1-\nu^2)}}_{\text{material}} \underbrace{\frac{1}{(b/t)^2}}_{\text{geometry}}$

Boundary conditions: flange curls, flanged holes

Normal stiffness of the plate: material, curved elements, foam filling

Width-to-thickness ratio: reducing width with beads and added edges (while maintaining moment of inertia)

5.

$$I = \frac{(1.5a)^2 t (3a + 1.5a)}{6} = \frac{27}{16} a^3 t, \text{ strength} \rightarrow \text{stiffness (5 pts)}$$

$$\left\{ \begin{array}{l} F_{\max} = \frac{4I\sigma_{\text{design}}}{Lc} \text{ where } \sigma_{\text{design}} = \begin{cases} \sigma_{\text{yield}} = 207 \text{ N/mm} \\ \sigma_{\text{buckle}} = \frac{748355}{(a/t)^2} \text{ N/mm} \end{cases} \text{ (5 pts)} \\ \rightarrow (\text{buckling}) F_{\max} = \frac{4 \frac{27}{16} a^3 t \frac{748355}{(a/t)^2}}{2550(0.75a)} = 2641t^3 \geq 6670 \text{ N} \rightarrow t \geq 1.36 \text{ mm (5 pts)} \\ k = \frac{48EI}{L^3} = \frac{48(207 \times 10^3) \frac{27}{16} a^3 t}{(2550)^3} = 1.375 \times 10^{-3} a^3 \geq 6670 \text{ N/mm} \rightarrow a \geq 169.3 \text{ mm (5 pts)} \end{array} \right.$$

$$\rightarrow A = 1151 \text{ mm}^2, (a/t) = 124$$

$$\text{OR } \left\{ \begin{array}{l} k = \frac{48EI}{L^3} \geq 6670 \text{ N/mm} \rightarrow I \geq 11.13 \times 10^6 \text{ mm}^4 \\ F_{\max} = \frac{4I\sigma_{\text{design}}}{Lc} = \frac{4I \frac{748355}{(a/t)^2}}{2550(0.75a)} \geq 6670 \text{ N} \rightarrow a^3 = 2.74 \times 10^6 t^2 \end{array} \right. \rightarrow I = \frac{(1.5a)^2 t (3a + 1.5a)}{6} = \frac{27}{16} a^3 t = 11.13 \times 10^6 \rightarrow t = 1.34$$

6.