Step 1: Estimating the axial load on each spring

$P = P_i + P_o$ $\quad P = 6\ kN$

$T_i = T_o$

$\Rightarrow \frac{P_i D_i}{d_i^3} = \frac{P_o D_o}{d_o^3} \Rightarrow \frac{P_i}{P_o} = \frac{D_o}{D_i}\left(\frac{d_i}{d_o}\right)^3$

given : $2c = D_o - d_i - D_i - d_o = d_o - d_i$

$\Rightarrow D_o - D_i = 2d_o$

$\Rightarrow \frac{D_o}{d_o} - \frac{D_i}{d_o} = 2$

$\Rightarrow 6 - \frac{D_i}{d_o} = 2$

$\Rightarrow \frac{D_i}{d_o} = 4$

$\therefore \frac{d_i}{d_o} = \frac{D_i}{d_o}\cdot\frac{d_i}{D_i} = \frac{4}{6} = \frac{2}{3}$

Thus : $\frac{D_i}{d_i} = \frac{D_o}{d_o} = 6$ and $\frac{D_i}{D_o} = \frac{d_i}{d_o} = \frac{2}{3}$

$\therefore \frac{P_i}{P_o} = \frac{D_o}{D_i}\left(\frac{d_i}{d_o}\right)^3 = \left(\frac{D_i}{D_o}\right)^2 = \frac{4}{9}$ and $P_i + P_o = 6\ kN$

$\Rightarrow$ $\boxed{P_i = 1.8462\ kN}$ and $\boxed{P_o = 4.1538\ kN}$

Step 2: Estimating the spring wire's diameters and coil diameters.

$T = K_W\left(\frac{8PD}{\pi d^3}\right) \quad T = 800\ MPa$

$K_W = \frac{4c-1}{4c-4} + \frac{0.615}{c} = 1.2525 \ (\because c = 6)$

$\therefore 800 \times 10^6 = \frac{1.2525 \times 8}{\pi} \times 4.1538 \times 10^3 \times \frac{D_o}{d_o^3}$

$\Rightarrow 60384.65038 = \frac{D_o}{d_o^3} = \frac{6}{d_o^2} \Rightarrow d_o = 9.968\ mm$

$\Rightarrow \boxed{d_o \approx 10\ mm}$

$\therefore d_i = \frac{2}{3} d_o = 6.6453\ mm$

$\Rightarrow \boxed{d_i \approx 7\ mm}$

$D_i = 4d_o = 39.872\ mm \Rightarrow \boxed{D_i \approx 40\ mm}$

$D_o = 6d_o = 59.872\ mm \Rightarrow \boxed{D_o \approx 60\ mm}$

Step 3 : Solid-length (L) and free-length (l)

$S = \frac{8PD^3 N_a}{Gd^4}$

for $N_{a_o} \rightarrow \delta_o = \frac{8 P_o D_o^3 N_{a_o}}{G d_o^4} \Rightarrow 50 \times 10^{-3} = \frac{8 \times (1846.2) D_o^3 N_{a_o}}{d_o^4 (82 \times 10^9)}$

↳ taking 9.968 mm

$\Rightarrow N_{a_o} = 5.6938$

$\Rightarrow \boxed{N_{a_o} \approx 6}$

for $N_{a_i} \longrightarrow \delta_i = \frac{8 P_i D_i^3 N_{a_i}}{G d_i^4} \Rightarrow N_{a_i} = 8.5409$

$\Rightarrow \boxed{N_{a_i} \approx 9}$

$\therefore L_o = d_o N_{t_o} = d_o (N_{a_o} + 1) = 70 \text{ mm}$

$L_i = d_i N_{t_i} = d_i (N_{a_i} + 1) = 70 \text{ mm}$

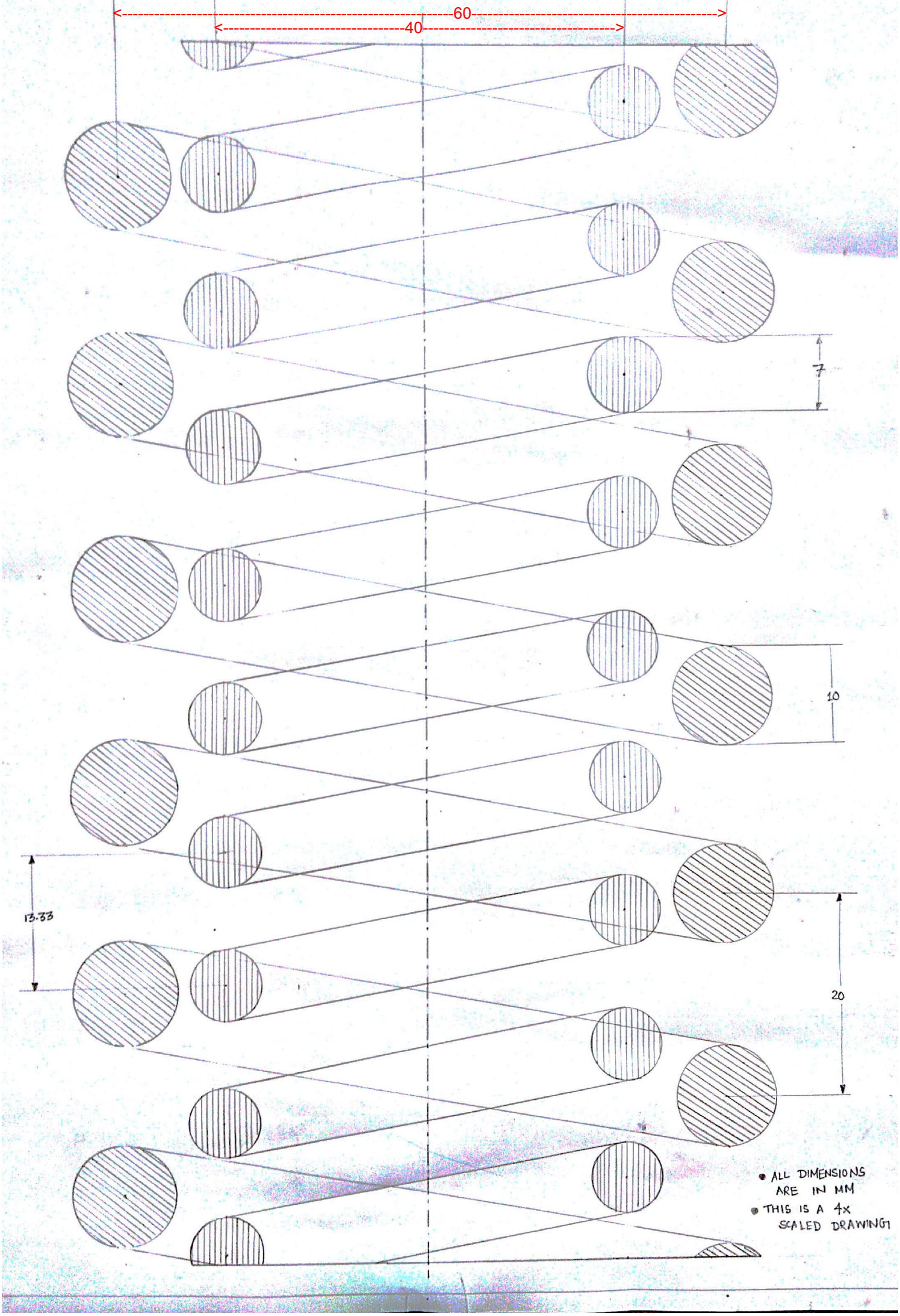
$\therefore \ell = L + \delta$

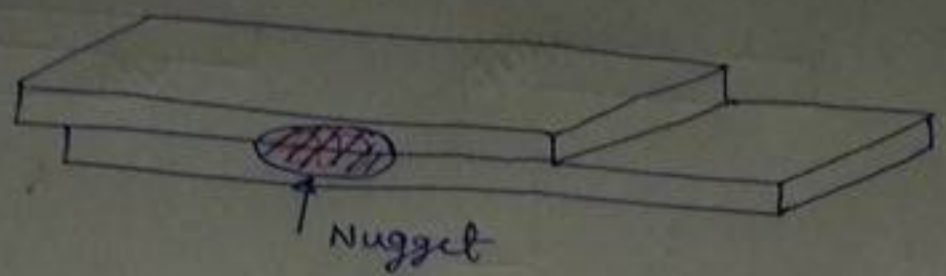
$\Rightarrow \ell = 120 \text{ mm}$

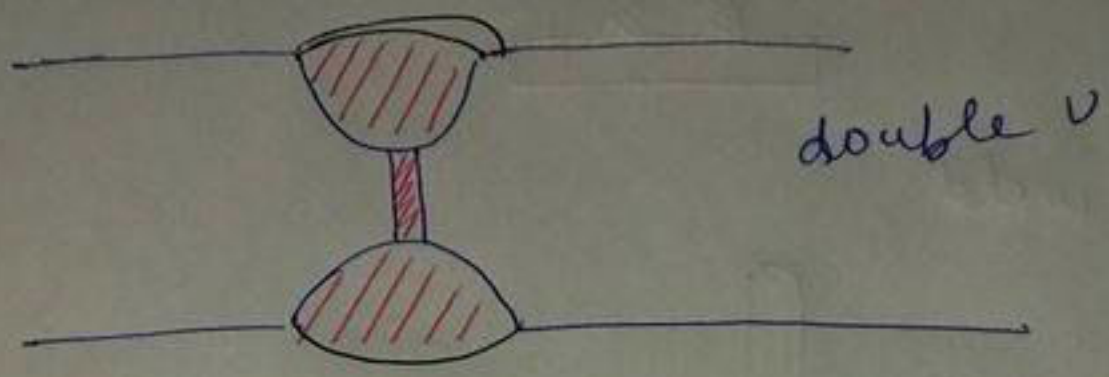
$\therefore P_i = \frac{\ell}{9} = 13.33 \text{ mm}$

Axial pitch $= \frac{\text{Free length}}{(N_t - 1)}$

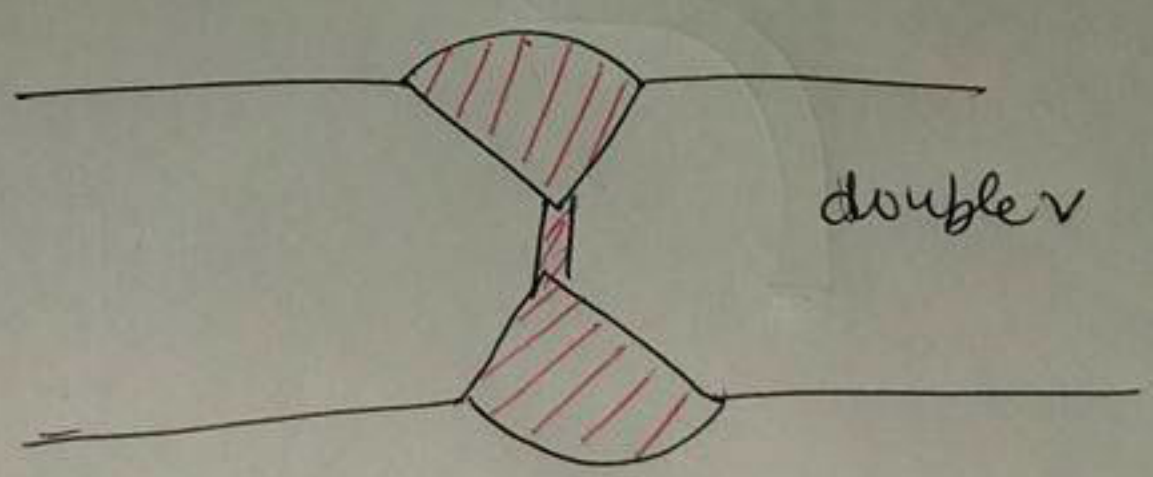
and $P_o = \frac{\ell}{6} = 20 \text{ mm}$

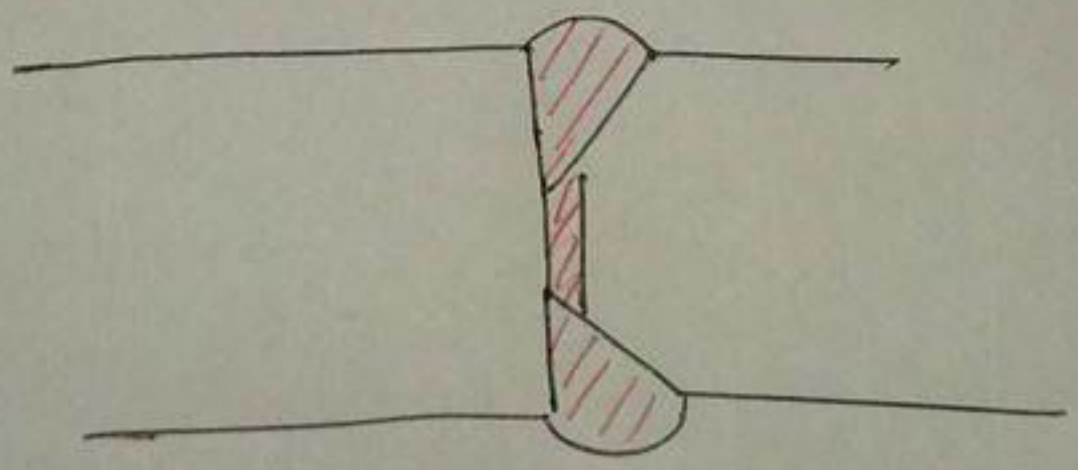


① 

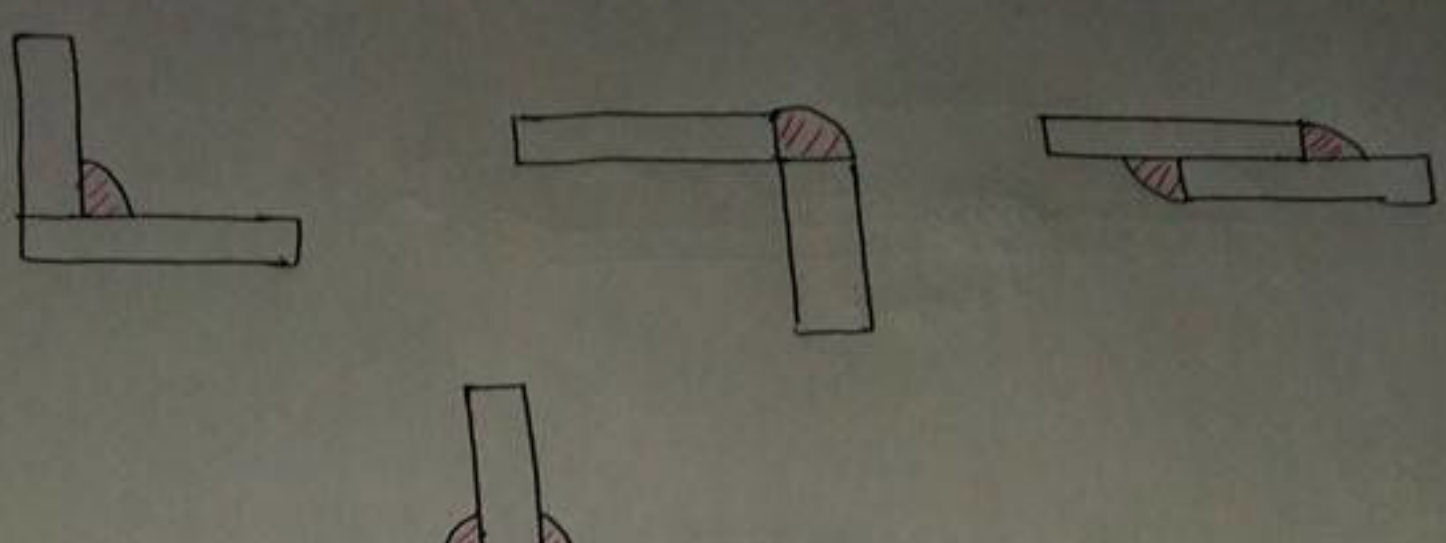
② 

③ double V

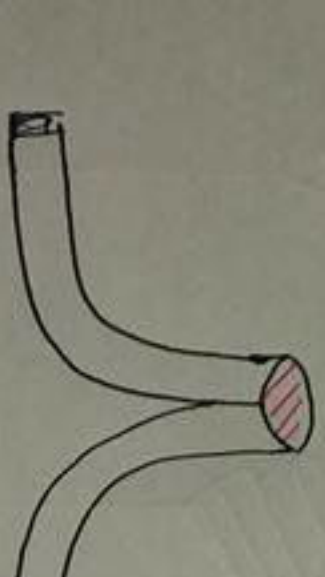


④ 

(5) fillet weld.

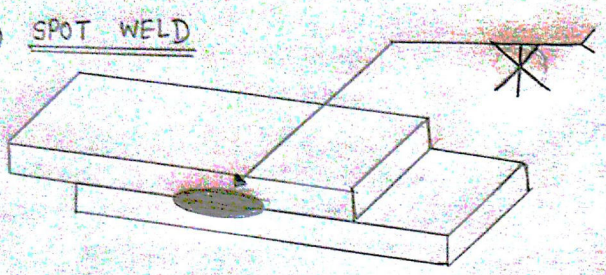


(6) edge weld

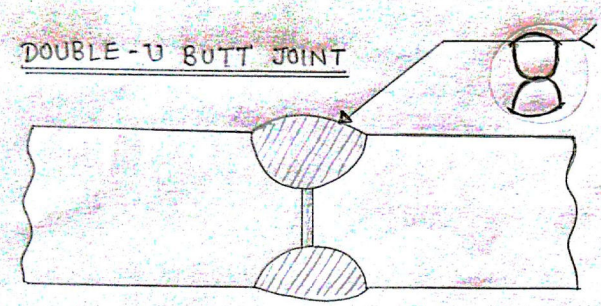


edge weld

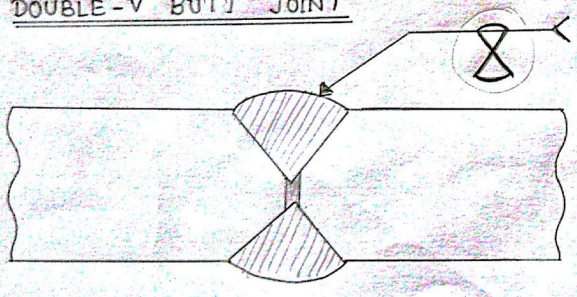
① SPOT WELD



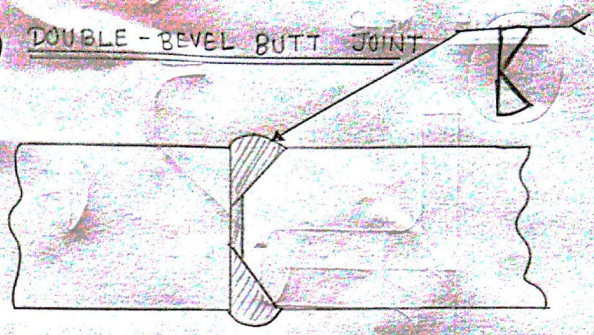
② DOUBLE-U BUTT JOINT



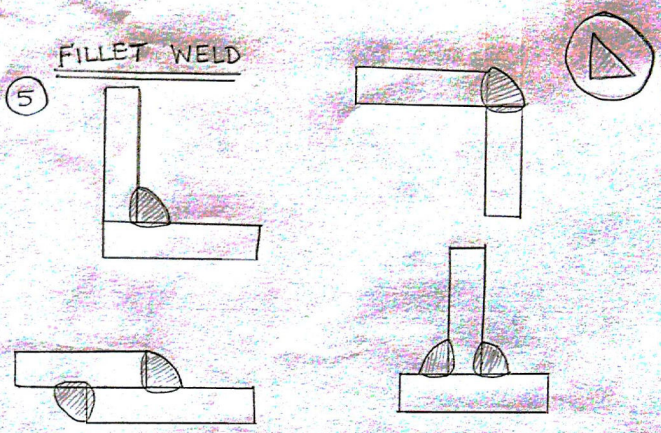
③ DOUBLE-V BUTT JOINT



④ DOUBLE-BEVEL BUTT JOINT



⑤ FILLET WELD



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MACHINE DESIGN PRACTISE – ASSIGNMENT ⑤

⑥ EDGE WELD