2.1. α) No β) Yes

γ) Yes δ) No

ε) No ς) Yes.

2.3. α) If $x \notin \bigcup A_i$, then for every i, $x \notin A_i$

hence, for every i, $x \in X \setminus A_i$

hence $x \in \bigcap (X \setminus A_i)$.

Conversely, if for every i, $x \in X \setminus A_i$,

then, for every i, $x \notin A_i$, hence $x \notin \bigcup A_i$.

Hence $x \in X \setminus \bigcup A_i$.

2.4. Example where $f(X \setminus A) \neq Y \setminus f(A)$:

$X = \{a, b\}$, $A = \{a\}$, $f(a) = f(b)$.

2.5. $\Rightarrow$ F closed in Y. Then $Y \setminus F$ is open.

Since f is cts, $f^{-1}(Y \setminus F)$ is open in X.

But $f^{-1}(Y \setminus F) = X \setminus f^{-1}(F)$, by 2.4.

Hence $X \setminus f^{-1}(F)$ is open, and $f^{-1}(F)$ is closed.

Prove the opposite implication!