Q2: For convinence, we define

$$\bigcup_{\mathcal{F}\subset\mathcal{E},\mathcal{F}\text{ countable}} \mathcal{M}(\mathcal{F}) = X$$

We first claim that X is a σ algebra. First, if $E \in X$, we have that there must be some countable $\mathcal{F} \subset \mathcal{E}$ with $E \in \mathcal{M}(\mathcal{F})$. Since $\mathcal{M}(\mathcal{F})$ is a σ algebra, we have that $E^c \in \mathcal{M}(\mathcal{F})$. Therefore $E^c \in X$. Now consider a sequence $\{E_i\}_{i\in\mathbb{N}} \subset X$. These correspond to some other sequence $\{\mathcal{F}_i\}_{i\in\mathbb{N}}$ of which they belong to. Since each $\mathcal{F}_i$ is countable and contained in $\mathcal{E}$, their countable union is countable as well and also contained in $\mathcal{E}$. We therefore have that

$$\bigcup_i E_i \in \bigcup_i \mathcal{F}_i \subset X$$

Where the second containment follows from the fact that $\bigcup_i \mathcal{F}_i$ is countable and contained in $\mathcal{M}(\cup_i\mathcal{F}_i)$ and hence in X. Hence X is a σ algebra. Now suppose that $A \in \mathcal{E}$. Then the singleton $\{A\}$ is a countable subset of $\mathcal{E}$. Therefore we have that

$$A \in \mathcal{M}(\{A\}) \subset X$$

Therefore we have that $\mathcal{E} \subset X$. We apply the lemma from class and conclude that $\mathcal{M}(\mathcal{E}) \subset X$. Now we wish to show that $X \subset \mathcal{M}(\mathcal{E})$. This follows immediately, since each $\mathcal{M}(\mathcal{F})$ is contained in $\mathcal{M}(\mathcal{E})$, hence their union must also be contained in $\mathcal{M}(\mathcal{E})$.