Functions		
Function	Convex?	Proof
$\mathbf{y} = \max(f_1, f_2)$	Yes, if f_1 and f_2 are convex functions	
$\mathbf{y} = \min(f_1, f_2)$	Not always	
$C = \{\mathbf{x} \in \mathbb{R}^n \mid \mathbf{A}\mathbf{x} = \mathbf{b}, \mathbf{A} \in \mathbb{R}^{m \times n}, \mathbf{b} \in \mathbb{R}^m\}$	It is an affine set (all affine set is a convex set)	
$y = \mathbf{c}^\mathsf{T}\mathbf{x}$ (linear function)	Yes (but not strictly convex)	
$y = \left\lVert \mathbf{x} \right\rVert_p$ (p-norm)	Yes (for any $p \in \mathbb{N}_+$)	$\lVert \theta\mathbf{x} + (1-\theta)\mathbf{y} \rVert \leq \theta \lVert \mathbf{x} \rVert + (1-\theta) \lVert \mathbf{y} \rVert$ (triangular inequality)
$f(g(\mathbf{x}))$	Yes, if f, g are convex	

Function	Domain	Codomain	Comments
System of linear equation: $\mathbf{b} = f(\mathbf{x}) = \mathbf{A}\mathbf{x}$	$D = \{\mathbf{x} \in \mathbb{R}^n \mid \mathbf{A}\mathbf{x} = \mathbf{b} \in C, \mathbf{A} \in \mathbb{R}^{m \times n}\}$	$C = \{\mathbf{b} \in \mathbb{R}^m \vert \mathbf{b} = \mathbf{A}\mathbf{x}, \forall\, \mathbf{x} \in D\}$	If D is an affine set, so C is also affine set which, in turn, is a convex set.

Sets		
Set	Convex?	Commens
Convex hull: $\text{conv } C = \left\{\sum_{i=1}^k \theta_i \mathbf{x}_i \mid \mathbf{x}_i \in C, 0 \leq \theta_i \leq 1, i = 1, \cdots, k, \sum_{i=1}^k \theta_i = 1\right\}$	Yes.	• A will be the smallest convex set that contains C. • conv C will be a finite set as long as C is also finite.
Affine hull: $\text{aff } C = \left\{\sum_{i=1}^k \theta_i \mathbf{x}_i \mid \mathbf{x}_i \in C, i = 1, \cdots, k, \sum_{i=1}^k \theta_i = 1\right\}$	Yes.	• A will be the smallest affine set that contains C. • Different from the convex set, θ_i is not restricted between 0 and 1 • aff C will always be an infinite set. If aff C contains the origin, it is also a subspace.
Conic hull: $A = \left\{\sum_{i=1}^k \theta_i \mathbf{x}_i \mid \mathbf{x}_i \in C, \theta_i > 0, i = 1, \cdots, k\right\}$	Yes.	• A will be the smallest convex conic that contains C. • Different from the convex and affine sets, θ_i does not need to sum up 1.
Euclidean ball: $B(\mathbf{x}_c, r) = \{\mathbf{x} \mid \lVert \mathbf{x} - \mathbf{x}_c \rVert_2 \leq r\}$ $B(\mathbf{x}_c, r) = \left\{\mathbf{x} \mid (\mathbf{x} - \mathbf{x}_c)^\mathsf{T} (\mathbf{x} - \mathbf{x}_c) \leq r\right\}$ $B(\mathbf{x}_c, r) = \{\mathbf{x}_c + r \lVert \mathbf{u} \rVert \mid \lVert \mathbf{u} \rVert \leq 1\}$	Yes	• $B(\mathbf{x}_c, r)$ as long as $r < \infty$. • $\mathbf{x}_c$ is the center of the ball. • r is its radius.
Ellipsoid: $\mathcal{E} = \left\{\mathbf{x} \mid (\mathbf{x} - \mathbf{x}_c)^\mathsf{T} \mathbf{P}^{-1} (\mathbf{x} - \mathbf{x}_c) \leq 1\right\}$ $\mathcal{E} = \{\mathbf{x}_c + \mathbf{A}\mathbf{u} \mid \lVert \mathbf{u} \rVert \leq 1\}$	Yes	• $\mathcal{E}$ is a finite set as long as $\mathbf{P}$ is a finite matrix. • $\mathbf{P}$ is symmetric and positive definite, that is, $\mathbf{P} = \mathbf{P}^\mathsf{T} \succ 0$. • $\mathbf{x}_c$ is the center of the ellipsoid. • The lengths of the semi-axes are given by $\sqrt{\lambda_i}$. • $\mathbf{A} = \mathbf{P}^{1/2}$. • $\mathbf{A}$ is invertible. When it is not, we say that $\mathcal{E}$ is a degenerated ellipsoid (degenerated ellipsoids are also convex).
$C = A \cup B$	Not always.	
$C = A \cap B$	Yes, if A and B are convex sets.	