1. [6 marks]
   Consider the following description logic ontology (TBox):
   i. Organism \equiv Animal \sqcup Plant
   ii. Person \sqsubseteq Animal
   iii. Grass \sqsubseteq Plant
   iv. Cow \sqsubseteq Animal \sqcap \forall eats.Grass
   v. Carnivore \equiv Organism \sqcap \forall eats.Animal
   vi. Rancher \equiv Person \sqcap \forall eats.Cow \sqcap \exists owns.Ranch

   (a) Express the axioms i, iv, and vi in informal English.
   (b) Translate the axioms i, iv, and vi into first-order logic formulas.
   (c) In the above ontology, what is the relation between Rancher and Carnivore? For example, is every Rancher a Carnivore? How about the other way round? Justify your answer by showing whether the subsumptions hold or not via the tableau algorithm.

2. (a) [2 marks] For the two argumentation networks below, give all admissible sets, preferred extensions and stable extensions.

   \[ \begin{array}{c}
   \text{a} \\
   \text{b} \\
   \text{c} \\
   \rightarrow \\
   \rightarrow \\
   \rightarrow \\
   \rightarrow \\
   \text{d} \\
   \end{array} \quad \begin{array}{c}
   \text{a} \\
   \rightarrow \\
   \text{b} \\
   \rightarrow \\
   \text{c} \\
   \rightarrow \\
   \text{d} \\
   \end{array} \]

   (a) (b)

   (b) [2 marks] Consider the following assertions with intended interpretations:
lp: Lower taxes cause increased productivity.
li: Lower taxes cause increased inequality.
l: Taxes should be lowered.
ln: In the past when taxes were lowered productivity didn’t increase.

These assertions and relations between them can be expressed as follows:
\{lp, li, ln, lp \rightarrow l, li \rightarrow \neg l, ln \rightarrow \neg lp\}

i. Express this information in the Besnard-Hunter framework. I.e. identify the various arguments and their relations.

ii. What arguments are supported? If different approaches (preferred, stable, etc.) lead to different conclusions, then given the conclusions arrived at by the different approaches.