LOGICS FOR DATA AND KNOWLEDGE REPRESENTATION
Written Exam Session III - Monday 08-09-2008

SURNAME: .... **NAME:** .... **N.** ....

1. Represent as a formal problem of the form $\pi = \langle\, I\,, S\,\rangle$ the following "Missionaries and Cannibals" problem, as stated by Amarel in 1968: "Three missionaries and three cannibals come to a river. A rowboat that seats two is available. If the cannibals ever outnumber the missionaries on either bank of the river, the missionaries will be eaten. How shall they cross the river?"

2. Let the following propositions be given.
$\alpha = (A \vee B) \wedge (\neg C \vee \neg D \vee E)$,
$\beta_1 = (A \vee B \vee C) \wedge (B \wedge C \wedge D \rightarrow E)$, $\qquad \beta_2 = (A \vee B) \wedge (\neg D \vee E)$

Draw the Venn diagram of $\alpha \rightarrow \beta_i$ for those i such that $\alpha \models \beta_i$.

3. For all formulas p, q:
Is $\forall x \, \forall y \, \exists z (p(x,y) \rightarrow (p(x,z) \wedge p(z,y))) \models \forall x \, \forall y (p(x,y) \rightarrow \exists z (p(x,z) \wedge p(z,y)))$?
yes ☐ no ☐

4. (Adapted from Smullyan, TARK 1986) Our action shall take place on an island in which each native is classified as either a knight or a knave. Knights make only true statements and knaves make only false ones. Any such island will be called a knight-knave island. On such an island, no native can claim to be a knave, since no knight would falsely claim to be a knave and no knave would correctly claim to be one. Our two main characters are a logician L who visits the island and meets a native N who makes a statement to L. An accurate logician L visits the island and meets a native N who makes a certain statement. Once the native has made this statement, it becomes logically impossible for L to ever decide whether N is a knight or a knave (if L should ever decide either way, he will lose his accuracy). What statement could N make to ensure this?

5. Let (D, W) be a closed *normal* default theory. If W is consistent then is (D, W) consistent?
(Justify your answer.) yes ☐ no ☐

6. Let default theory $\Delta = (D, W)$ be defined as follows.
$$D = \left\{ \frac{: MA}{\neg B}, \frac{: MB}{\neg A} \right\} \qquad W = \{\neg A \rightarrow E, E\}.$$
Define Δ's extensions, if any. Motivate in details your answer.

7. Translate into $\mathcal{ALN}$ "Veal-parmesan is a meat dish with ingredient veal and exactly 9 ingredients."

8. Prove the following equivalences.
1. $\neg (C \sqcap D) \equiv \neg C \sqcup \neg D$ $\qquad$ 2. $\neg \exists R.C \equiv \forall R. \neg C$

9. Let ontology $\mathcal{O}$ defined by the set of the following axioms and assertions:

Person $\sqsubseteq \forall$parent.Person, Person $\sqsubseteq \forall$parent.Adult,
Person(PAOLO), parent(PAOLO, JOHN).

1. Is $\mathcal{O} \models$ Adult(JOHN)?

2. What is the retrieval set $\{a \,|\, \mathcal{O} \models$ Person$(a)\}$?

3. What is the realization set $\{C \,|\, \mathcal{O} \models C($JOHN$)\}$?