Homework has 3 PARTS and 6 Problems
SOLVE and SUBMIT as many problems as possible.
ALL SOLUTIONS must be TYPED.

You must TYPE the statement of each problem you are solving; otherwise problem will not be considered for correction.

We will CORRECT ONLY ONE PROBLEM from each PART.

Please, CIRCLE the problem in EACH PART you want us to correct.

You will get 1extra credit point for each solved and submitted Problem different from the 3 you chose for us to correct.
PART ONE – 5pts

1. CONCEPTUALIZATION DEFINITION (NILSON)
   • Conceptualization – step one of formalization of knowledge in declarative form.
   • \( C = (U, F, R) \)
   • \( U \) – Universe of discourse; it is a FINITE set of objects.
   • \( F \) – Functional Basis Set; Set of functions (defined on \( U \)). Functions may be partial.
   • \( R \) – Relational Basis Set; Set of relations defined on \( U \).
   • Remark: sets \( R, F \) are FINITE.

PROBLEM 1
Conceptualize the following situation using the above definition.

In a room there are 3 girls, 4 boys, and 2 cars – one red and one blue. The following properties must be true.

1. Each girl likes exactly one boy.
2. Some boys like some girls.
3. Everybody (boys and girls) like some car.
4. Three boys like a red car.
5. Two girls like a blue car.
Use the following notation

U – Universe of discourse is the set

U = { o1, o2, o3, o4, o5, o6, o7, o8, o9 }

R – Relational Basis Set; Set of relations

R = { GIRL, BOY, CAR, REDCAR, BLUECAR, LIKE }

USE INTENDED Interpretation, i.e.

Relation GIRL is defined by a property x is a girl
Relation BOY is defined by a property x is a boy
Relation CAR is defined by a property x is a car
Relation CAR is defined by a property x is a car
Relation REDCAR is defined by a property x is a red car
Relation BLUECAR is defined by a property x is a blue car
Relation LIKE is defined by a property x likes y

Remark that the relations GIRL, BOY, CAR, REDCAR, BLUECAR are one argument relations and the relation LIKE is a two argument relation and all of them are defined on the Universe U
PART TWO - 10pts

PREDICATE LOGIC CONCEPTUALIZATION

1. Translations from Natural Language

PROBLEM 2

P1. Translate into plain English predicate logic examples from our BOOK, page 23
P2. Write a FULL solution following the Predicate Logic (1) Lecture Notes, with explanation and justification of correctness for the examples on the book page 24, i.e. follow the steps:

1. Identify the domain: always a set $X \neq \varnothing$
2. Identify predicates (simple: atomic)
3. Identify functions (if needed)
4. Identify the connectives
5. Identify the quantifiers $\forall x, \exists x$ or Restricted Quantifiers $\forall P(x), \exists Q(x)$
6. Write a formula using symbols from 2,3,4,5
   Use restricted domain quantifier translation rules, where needed
7. Write LOGIC formula – without Restricted Quantifiers

P3. This Problem is about different Knowledge representations
FOLLOW PROBLEM 2 steps to write detailed solution to part b) of problems 2, 3 from our BOOK, page 39 Follow Book or Busse Notes to write solution of part a)

PREDICATE LOGIC CONCEPTUALIZATION

2. Translations from Mathematics Language

PROBLEM 3
Here is a mathematical statement S:

For all natural numbers n the following implication holds:

IF \( n < 0 \), then there is a natural number m, such that \( m+n < 0 \)

1. Re-write S as a “formula” MF that only uses mathematical and logical symbols
2. Translate your MF to a correct logic formula LF
3. Argue whether the statement S it true or false

PART THREE – 10pts
RULE BASED SYSTEMS

PROBLEM 4
**P1.** CONCEPTUALIZE problem 5 from our BOOK, page 39 in *Propositional Logic* and solve it using Conflict Resolution.

**P2.** CONCEPTUALIZE problem 5 from our BOOK, page 39 in *Predicate Logic convention* using predicates

\[ \text{attribute}(x, \text{valueOf attribute}), \]
\[ \text{attribute}(\text{object}, \text{.valueOf attribute}) \]

WRITE a format of a database TABLE needed for solution of **P2**

**PROBLEM 5**
CONCEPTUALIZE the EXAMPLE (Rules R1- R4) on page 47 of the BOOK in *Propositional Logic*.

EXPLAIN the role of Questions posed to the system (in your conceptualization) and use backward chaining to solve the problem depending on the answers given to the system.

**PROBLEM 6**

**P1.** Write detailed solution to problems 2 from BUSSE BOOK

**P2.** Write detailed solution to problems 4 from BUSSE BOOK