Problem 1

**NULL Value:**
A value of a given attribute which is unspecified (i.e. is not) from the domain of the attribute or is different from any other value of that domain is called a NULL value. It may mean any of the following:
- Missing entry
- Unknown value
- Not applicable
And hence it is ambiguous.

**Role:**
Role is the nature (or function) of an entity in a given relationship.

Problem 2

A weak entity class cannot be directly represented as a schema as it does not have an unique key. It can be represented as a schema in which the key consists of
- Key attributes from the entity class involved in the relationship
- Discriminators from the weak entity class itself

Problem 3

Following is the relation based schema of the given ER diagram:
Entity_1 (key_1, attribute_1)
Entity_2 (key_2, attribute_2)
Rel_12 (key_1, key_2, rel_attribute)
Problem 4
Following is the ER diagram representing the problem domain specified in the problem:

Since it is a disjoint specialization, all of the following conversions apply:

Possible answer 1:
Vehicle (VIN, year, make, model, mileage)
Car (VIN, nameLastOwner, currentOwner, dateOil, mileageOil)
Truck (VIN, loadCapacity, driver, maxDailyMiles)

Possible answer 2:
Car (VIN, year, make, model, mileage, nameLastOwner, currentOwner, dateOil, mileageOil)
Truck (VIN, year, make, model, mileage, loadCapacity, driver, maxDailyMiles)

Possible answer 3:
Vehicle (VIN, year, make, model, mileage, nameLastOwner, currentOwner, dateOil, mileageOil, loadCapacity, driver, maxDailyMiles)

Problem 5
The given relational schema is R (A, B, C, D, E, F, G, H)
Given functional dependencies are:
FD1: A -> C, D
FD2: B -> E, F, G
FD3: C -> E, F

Reflexivity:
From FD2 we obtain
FD3: B, D -> E, F, G, D
Augmentation:
From FD2 (augmenting with H) we obtain:

\textit{FD4}: \( B, H \rightarrow E, F, G, H \)

Transitivity:
Decomposing FD1 we obtain:

FD5: \( A \rightarrow C \)

Using FD5 and FD3 we obtain:

\textit{FD6}: \( A \rightarrow E, F \)

Decomposition:
Decomposing FD1 we obtain:

\textit{FD7}: \( A \rightarrow D \)

Union:
Using FD1 and FD6 we obtain:

\textit{FD8}: \( A \rightarrow C, D, E, F \)

\textit{Pseudo-Transitivity}:
Using FD7 and FD3 we obtain:

\textit{FD9}: \( B, A \rightarrow E, F, G, D \)

Problem 6
1NF specifies that every attribute of a schema must take its values from an atomic domain. It is now primarily of interest from a historical perspective.

Problem 7

The set of functional dependencies that are full, maximal and non-trivial are:

FD1: \( A, B \rightarrow C, D, E, F, G, H \)

FD2: \( A \rightarrow C, D \)

FD3: \( B \rightarrow E, F, G \)

FD2 and FD3 violate 2 NF, so the relational schema \( R (A, B, C, D, E, F, G, H) \) must be broken down. As you would notice below, it has to be broken down twice and the order is not relevant.

\( R (A, B, C, D, E, F, G, H) \)
- R12 (\( A, B, E, F, G, H \))
  - \textbf{R121} (\( A, B, H \))
  - \textbf{R122} (\( B, E, F, G \))
- \textbf{R22} (\( A, C, D \))

Alternatively

\( R (A, B, C, D, E, F, G, H) \)
- R12 (\( A, B, C, D, H \))
  - \textbf{R121} (\( A, B, H \))
  - \textbf{R122} (\( A, C, D \))
- \textbf{R22} (\( B, E, F, G \))