Assignment 4

Instructions

1. This assignment contains two sections (A&B)
2. Answer all questions in both sections
3. You are required to keep the previous groups you made for the previous assignment.
4. Also, only a group leader is required to submit to represent a group
5. Deadline is indicated in e-learning platform where you will submit it.
6. Any similarities, no matter how small, will be treated as collusion and penalized accordingly. Your work must be your own.
7. You may make (reasonable) use of ideas from third-party sources, provided these are cited as References within your answers and included in the Reference list at the end. Do not copy or closely paraphrase text. If any text is reproduced verbatim (i.e. if you quote a source – even the lecture slides), then this must be placed inside quotation marks "__". Make sure you follow these rules, otherwise your use of third-party sources and ideas may well be considered as plagiarism. Standard University policies apply to this and you can check them online for more guidance.

Section A

1. Explain the main differences between a Finite State Machine (FSM) and a Petri Net in terms of representation, modeling capability, and application domain.
2. Describe how concurrency and synchronization are represented in Petri Nets but not in FSMs. Give an example to support your explanation.
3. Discuss the limitations of FSMs when modeling complex systems such as communication protocols or manufacturing processes.
4. Compare the deterministic and non-deterministic FSMs. In which types of real-world systems would non-deterministic FSMs be more appropriate?
5. Petri Nets are often described as both a graphical and mathematical tool. Explain what this means and why both aspects are important.

Section B

Question 1

You are required to model the behavior of an Automated Parking Gate System.
The gate operates as follows:

    a. The system waits for a vehicle to arrive.
    b. When a vehicle is detected, the driver inserts a parking card.
    c. If the card is valid, the gate opens; otherwise, the gate remains closed.
    d. Once the car passes, the gate closes and returns to the idle state.

Tasks:

1. Identify all states, events (inputs), and actions (outputs.
2. Draw a State Transition Diagram (FSM) showing the states and transitions.
3. Provide a state transition table.
4. Briefly explain how the FSM ensures reliability and safety in the system.

Question 2

Consider a Vending Machine System that performs the following sequence:

a. The user inserts a coin.
b. The machine verifies the coin.
c. The user selects a product.
d. The machine dispenses the product and returns change if necessary.

Tasks:

1. Identify places, transitions, and tokens for this system.
2. Draw the Petri Net diagram representing the process.
3. Explain how concurrency or synchronization can be modeled using Petri Nets in this context.
4. Discuss one advantage of using Petri Nets over FSMs in modelling concurrent systems.

Question 3

A university database keeps information about Students, Courses, and Instructors.

a. A student can register for multiple courses.
b. Each course can have multiple students.
c. Each course is taught by one instructor, but an instructor can teach several courses.

Tasks:

1. Identify all entities, attributes, and relationships.
2. Draw an ER diagram that represents the database.
3. Indicate cardinalities and primary/foreign keys.
4. Convert the ER diagram into 3NF relational schema.

Question 4

Using the ER model from Question 3, assume the university wants to track student grades and attendance for each course.

Tasks:

1. Modify your ER model to include the new requirements.
2. Write the corresponding relational schema with appropriate keys and constraints.
3. Briefly explain how this data model can support business intelligence reporting (e.g., student performance analytics)

All the best!