41. As we have discussed, the practical application of all the topics in the class. Now you are required to submit at least two real world applications of the following topics.

(a) Propositional Logic

1) Translating English Sentences into logical statements

Like any other human language, English sentences can be ambiguous. This ambiguity might lead to uninformed decision-making and other fatal errors. To remove this ambiguity, we can translate these English sentences into logical expressions with the help of Propositional Logic. Note that sometimes this may include making a few assumptions based on the sentence's intended meaning.

Example: Given a sentence "*You can purchase this book if you have $20 or $10 and a discount coupon.*" Now, this is a bit complex to be understood at once. So we translate this into a logical expression that will make it simple to understand. Let *a*, *b*, *c,* and *d* represent the sentences "*You can purchase this book.*", "*You have $20.*", "*You have $10.*", and "*You have a discount coupon.*" respectively. Then the given sentence can be translated to $(b \lor (c \land d) \to a$, which simply means that "if you either have $20 or $10, along with a discount coupon, then you can purchase the book."

2) Logical Puzzles

Puzzles that are solved using reasoning and logic are called logical puzzles. They can be used for brain exercises, recreational purposes, and for testing a person's reasoning capabilities. Solving such puzzles is generally tricky, but it can be done easily using propositional logic. Some of the famous logic puzzles are *the muddy children puzzle*, *Smullyan's puzzles about knights and knaves,* etc.

Example:

Problem Statement: There is an island that has two kinds of inhabitants, knights, who always tell the truth, and their opposites, knaves, who always lie. You encounter two people A and B. Determine what are A and B if A says "B is a knave" and B says "Both of us are of same types"?

Solution: Let *p* and *q* be the statements that *A* is a knight and *B* is a knight, respectively, so $\neg p$ and $\neg q$ are the statements that *A* is a knave and *B* is a knave, respectively. Let's assume *A* is a knight, i.e., *p* is true. So *A* is telling the truth, which means $\neg q$ is true. Now as *B* is a knave whatever it is saying is a lie, i.e., $(p \land q) \lor (\neg p \land \neg q)$ is false, which simply means if either of them is a knave then the other one is a knight or vice-versa. Now, as per the assumption, this statement is true. So we can conclude that *A* is a knight and *B* is a knave.

(b) Predicates and quantifiers

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(c) Sets

1.Kitchen utensils

In the kitchen, utensils are organised in such a way that plates are kept separate from spoons. Every utensil is categorized appropriately and kept somewhere else.

A(Types of plates)={Bone china, earthenware, porcelain, melamine and stoneware}

B(Types of spoons) ={wooden,slotted,mixing,salad}

2. mobile showrooms

we see that sophisticated phones like Galaxy duos, Lumia, and so on are segregated from plain mobiles. OR that each brand of phone is kept separate from other brands

iphones = {6,7,8,x}

Samsung = {J7, a7, galaxy}

(d) Functions

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(e) Relations

1. The Relationship between Age and Height

If you took a group of people at random, you would notice a relationship between their ages and height. This is because people get taller with time and then remain at the same height for a while.

This is a relation because if you input a specific age and check all the people of that age, you would get different heights.

2. A Semester in School

In a college, students take different classes to fulfill the requirements of a given course.

A student may have different grades for different subjects. Therefore, there is a relation between the student and his grades.

(f) Sequence and Series

1. Pyramid-like patterns, where objects are increasing or decreasing in a constant manner. Ideas for this are seats in a stadium or an auditorium. A situation might be that seats in each row are decreasing by 4 from the previous row. I use this in one of my arithmetic sequence worksheets.

2. Filling something is another good example. The container can be empty or already have stuff in it. An example could be a sink being filled or a pool being filled. (Draining should also be considered!) The rate at which the object is being filled versus time would be the variables.

(g) Graph theory

1. Airline Scheduling (Flow problems)

flights are taken as the input to create a directed graph. All serviced cities are the vertices and there will be a directed edge that connects the departure to the arrival city of the flight. The resulting graph can be seen as a network flow. The edges have weights, or flow capacities, equivalent to the number of crew members the flight requires. To complete the flow network a source and a sink vertex have to be added.

2. Directions in a map (Shortest path)

The first step is to transform a map into a graph. For these all-street intersections are considered as vertices and the streets that connect intersections as edges. The edges can have weights that represent either the physical distance between vertices, or the time that takes to travel between them Now, to give the direction between two points in the map, an algorithm only needs to calculate the path with the lowest sum of edge weights between the two corresponding vertices. This can be done using Dijkstra's algorithm