1. (3 points) Is the following a valid argument or fallacy? *If it is Sunday, then the store is closed. The store is closed. Therefore, it is Sunday.* You must explain your answer. Include the name of the fallacy, if you think this argument is a fallacy.

2. (2 points) Name the argument form of the following argument: *Dogs eat meat. Fluffy does not eat meat. Therefore, Fluffy is not a dog.*

3. (5 points) Use the rules of inference to prove the conclusion r given (all 1,2,3 and 4) the four premises listed below. Write your solution as a numbered sequence of statements. Identify each statement as either a premise, or a conclusion that follows according to a rule of inference from previous statements, or it is equivalent to a previous statement by the rules of logical equivalences. You should give the rule used by name and refer by number to the previous statement(s) that the rule was applied to.

   1. $p \to \neg q$ (premise)
   2. $p \vee u$ (premise)
   3. q (premise)
   4. $((r \wedge t) \vee p) \vee \neg u$ (premise)

4. (5 points) Formalize the following argument by using the given predicates and then rewriting the argument as a numbered sequence of statements. Identify each statement as either a premise, or a conclusion that follows according to a rule of inference from previous statements. In that case, state the rule of inference and refer by number to the previous statements that the rule of inference used.

   Lions hunt antelopes. Ramses is a lion. Ramses does not hunt Sylvester. Therefore, Sylvester is not an antelope.

   Predicates: H(x,y)=" x hunts y", L(x)="x is a lion" and A(x)="x is an antelope". The domain of discourse is all animals.

5. (4 points) Prove directly that the product of an even and an odd number is even.

6. (4 points) Prove by contraposition for arbitrary $x \neq 0$: if x is irrational, then so is $1/x$.

7. (2 points) Prove that there is a positive integer n that satisfies $2n+1 \geq 33$. Do not overthink this problem. Do not write more than logically necessary to prove existence.

8. (5 points) Prove that for any positive integer n, there is an even positive integer k so that
$$\frac{1}{n+2} \leq \frac{1}{k-1} < \frac{1}{n}.$$

In your proof you can refer to simple theorems such as "even plus even is even", and "odd +even is odd" etc without proofs. You don't have to use the definition of odd/even numbers.

9. (4 points extra credit) We have learned that $\sqrt{2}$ is not rational. However, $\sqrt{2}$ can be arbitrarily well approximated by rational numbers. The goal of this programming exercise is to find the best approximation $p/q \approx \sqrt{2}$ with $2 \leq q \leq 100,000$.

   Write a Python program that iterates through all these q values. For each q, use the reasonable constraint $1.4 < p/q < 1.5$ to come up with a small set of integer candidates p for a good approximation. Your program should output the (p, q) for which p/q approximates $\sqrt{2}$ best. Your program must not contain hardcoded approximations to $\sqrt{2}$, other than the numbers 1.4 and 1.5, or use Math.sqrt() or equivalent.