Name:____________________________

Math 3053 Section 01 *Practice Exam 2* *November 19, 2019*

Follow the instructions for each question and show enough of your work so that I can follow your thought process. If I can't read your work, answer or there is no justification to a solution, you will receive little or no credit!

1. Let P and Q be statements. Prove that the following statement is always true:

$$[P \wedge (P \Rightarrow Q)] \Rightarrow Q\,.$$

2. Let P and Q be statements. Prove that $(P \Longrightarrow Q) \Longleftrightarrow (\neg P \vee Q)$.

3. Prove that $\sqrt{10}$ is irrational.

4. Prove there exists irrational numbers x and y such that x^y is rational.

5. Prove that $(1+x)^n \geq 1 + nx$ for every $n \in \mathbb{N}^+$ and every $x \in (-1, \infty)$.

6. Let f and g be infinitely differentiable functions on $\mathbb{R}$. Prove that for any $n \in \mathbb{N}$ the following holds:

$$(fg)^{(n)}(x) = \sum_{k=0}^{n} \binom{n}{k} f^{(n-k)}(x) g^{(k)}(x)\,.$$

7. Let $n \in \mathbb{N}$. Prove that

$$\sum_{k=0}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}\,.$$

8. Assume that there is a polynomial, $p(n)$, of degree 3 such that

$$p(n) = \sum_{k=0}^{n} k^2\,.$$

Find the formula for $p(n)$ and prove that the formula is correct.

9. Prove the product of n rational numbers is again a rational number. Is the product of two irrational numbers always irrational? Prove or disprove you claim.