Good luck!

1. [20 pts] Expand \((3x - 2y)^3\).

2. [20 pts] Use the binomial theorem to show that: \[ \sum_{k=0}^{n} \binom{n}{k} 2^k = 3^n. \]

3. [20 pts] Find the coefficient of \(x^2y^3z^4\) in the expansion of \((x+y+z)^9\).

4. [20 pts] Determine whether each relation defined on the set of positive integers is reflexive, symmetric, antisymmetric, transitive, and/or a partial order:
   a) \((x,y) \in R\) if \(x = y^2\)
   b) \((x,y) \in R\) if \(x > y\)
   c) \((x,y) \in R\) if 3 divides \(x - y\)
   d) \((x,y) \in R\) if \(x = y\)

5. [10 pts] Let \(X = \{1, 2, 3, 4, 5\}\), \(Y = \{3, 4\}\), and \(C = \{1, 3\}\). Define \(R\) on \(\rho(X)\), the power set of \(X\), as \(A R B\) if and only if \(A \cup Y = B \cup Y\). Show that \(R\) is an equivalence relation.

6. [10 pts] By drawing a digraph, give an example of an equivalence relation on \(\{1, 2, 3, 4, 5, 6\}\) having exactly 4 equivalence classes.

7. [20 pts] Draw the Hasse diagram for the partial ordering \(x\) divides \(y\) on the set \(\{2, 3, 6, 9, 12, 18, 27\}\).

8. [15 pts] Give an example of a function that
   a) is 1-1 but not onto
   b) is onto but not 1-1
   c) is neither 1-1 nor onto

9. [20 pts] Let \(f: S \to T\) and \(g: T \to U\) be functions. Find an example where \(g \circ f\) is 1-1 but \(g\) is not 1-1.

10. [20 pts] Find the composition of the following cycle representing a permutation on \(A = \{1, 2, 3, 4, 5, 6, 7, 8\}\). Write your result as the composition of disjoint cycles.