1. (6%) Try to use a generalized list to represent the following polynomial:
\[ P(x, y, z) = 3x^3y^4z^2 + 5x^5y^7z^2 + 4x^5y^3z^2 + x^4y^2z \]

2. (12%) Write the data structure and programs for all stack operations (Insert, Delete, Full and Empty) using C++ or C.

3. (7%) Given two polynomials as follows:
\[ M(x) = x^{10} + 3x^{10} + 1 \]
\[ K(x) = x^5 + 8x^3 + x^2 + 2 \]
Write an array representation of two polynomials.

4. (10%) For the following element sequence:
1, 6, 7, 2, 4, 3, 5, 8
a) Determine the binary search tree obtained when the elements are inserted one-by-one in the order into an initially empty tree.
b) Do a) above for AVL tree.

5. (10%) For the following element sequence:
2, 7, 1, 8, 4, 5, 9, 0, 3, 6
a) Determine the 2-3 tree (a B-tree of order 3) obtained when the elements are inserted one-by-one in the order into an initially empty tree.
b) Do a) above for B-tree of order 6.

6. (5%) Merge the two binomial heaps in the Figure below:
7. (12%) Let \( f(n) = \Theta(T(n)) \). Derive \( f(n) \) in the simplest formula for each of the following \( T(n) \).
   a. \( T(n) = 2T(n/2) + n^2; \ T(c) = c, \text{ if } c < 2 \).
   b. \( T(n) = 2T(n/2) + n \log n; \ T(c) = c, \text{ if } c < 2 \).
   c. \( T(n) = 2T(n/2) + n; \ T(c) = c, \text{ if } c < 2 \).
   d. \( T(n) = 2^0x_n + 2^1x_{k-1} + 2^2x_{k-2} + \ldots + 2^kx_{k-k}; \text{ where } 2^k = n \).
   e. \( T(n) = 1 + 1/2 + 1/3 + \ldots + 1/(n-1) + 1/n \).
   f. \( T(n) = 1 + 1/2^2 + 1/3^2 + \ldots + 1/((n-1)^2 + 1/n^2) \).

8. (5%) Let a circulated gray code be a gray code in which the first and the last elements also have one and only one different bit. Prove that the number of elements in a circulated gray code must be even. (No more than 3 sentences.)

9. (8%) Given \( n \) items \( (a_1, a_2, \ldots, a_n) \) with distinct integer keys ranged from 1 to \( n \), design an efficient algorithm to sort the \( n \) items and show its time complexity. But, some books about algorithms mention \( \text{“the lower bound for sorting is } \Omega(n \log n) \text{”} \) (this seems contradictory to your algorithm). First, correct the wording in the quote. Then, explain why. (No more than 3 sentences.)

10. (10%) What is the polynomially reducible? Prove that the 3SAT problem is NP-complete.

11. (7%) Show the time complexity of Strassen’s algorithm used for matrix multiplication. You don’t need to write out all matrix multiplication types.

12. (4% / 4%) State Graham’s scan algorithm for convex hull construction. Analyze the time complexity.