Run time Analysis (Big O)

Operation	Vector	Hash Table	Binary Search Tree
Read file by each line	O(n)	O(n)	O(n)
Validate line	O(1) per line	O(1) per line	O(1) per line
Insert into structure	O(1)	O(1) avg / O(n) worst	O(log n) avg / O(n) worst
Validate prerequisites	O(n x m)	O(n x m)	O(n x m)

N is the number of courses

M is the average number of prerequisites per course

Cost per line = 1 unless it calls for a function

Advantages & Disadvantages

Vectors

Advantages:

- Simple and easy to implement.
- Fast insertion (push_back() is O(1)).
- Good if the number of courses is small.

Disadvantages:

- Searching is slow (O(n)).
- Sorting is required before listing courses (O(n log n)).
- Not efficient for large data sets.

Hash Tables

Advantages:

- Very fast insert and search (O(1) average).
- Efficient for direct access by course number.

- Perfect for fast lookup of individual course data.

Disadvantages:

- Unordered by default – sorting is required for Option 2.
- May use more memory due to hashing.
- Worst-case search is O(n) if collisions are bad.

Binary Search Trees (BST)

Advantages:

- Maintains sorted order naturally — great for Option 2.
- Balanced BSTs provide O(log n) insert/search.
- Easy to do in-order traversal for sorted output.

Disadvantages:

- Slower insert and search than hash table in best case.
- Must be balanced for optimal performance.
- More complex implementation.

Recommendation

After looking at how each structure performs, I'd go with the Hash Table. It's the fastest when it comes to adding and searching for courses, which is important for Option 3: finding course info quickly. Since hash tables provide O(1) average-case time for insert and search, they're great for speed. The only downside is that they don't keep things in order, but it is not a problem because I can sort the courses before listing them for Option 2.

But overall,

Fastest = Hash Table

Best for sorting = BST

Easiest to work with = Vector

Out of all of them, the Hash Table is fast and efficient, and it does exactly what's needed for this program.