# Data Structures with C++

## Full Semester Syllabus

# Data Structures with C++ – Full Semester Syllabus

## 01 – Introduction
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_hello.cpp
- 02_io.cpp
- 03_struct.cpp
- 04_class.cpp
- 05_pointers.cpp
- 06_references.cpp
- 07_new_delete.cpp
- 08_array_traverse.cpp
- 09_func_array.cpp
- 10_2d_array.cpp
- 11_bubble_sort.cpp
- 12_linear_search.cpp
- 13_menu.cpp
- 14_file_io.cpp
- 15_inline_const.cpp
- 16_swap.cpp
- 17_sum_array.cpp
- 18_max_min.cpp
- 19_basic_loop.cpp
- 20_summary.cpp

## 02 – Arrays
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_array_create.cpp
- 02_insert_shift.cpp
- 03_delete_shift.cpp
- 04_modify.cpp
- 05_linear_search.cpp
- 06_binary_search.cpp
- 07_bubble_sort.cpp
- 08_selection_sort.cpp
- 09_insertion_sort.cpp
- 10_merge_sort.cpp

- 11_quick_sort.cpp
- 12_reverse.cpp
- 13_max_min.cpp
- 14_sum_avg.cpp
- 15_matrix_add.cpp
- 16_matrix_mul.cpp
- 17_transpose.cpp
- 18_rotate_k.cpp
- 19_unique_elements.cpp
- 20_set_ops.cpp

## 03 – Strings
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_create.cpp
- 02_input.cpp
- 03_concat.cpp
- 04_length.cpp
- 05_compare.cpp
- 06_substring.cpp
- 07_palindrome.cpp
- 08_reverse.cpp
- 09_count_vowels.cpp
- 10_count_words.cpp
- 11_remove_spaces.cpp
- 12_freq_count.cpp
- 13_find_sub.cpp
- 14_replace_sub.cpp
- 15_to_upper.cpp
- 16_sort_chars.cpp
- 17_anagram.cpp
- 18_longest_word.cpp
- 19_unique_chars.cpp
- 20_summary.cpp

## 04 – Singly Linked List
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_create_traverse.cpp

- 02_insert_head.cpp
- 03_insert_tail.cpp
- 04_insert_pos.cpp
- 05_search.cpp
- 06_delete_head.cpp
- 07_delete_value.cpp
- 08_reverse_iter.cpp
- 09_reverse_rec.cpp
- 10_middle_fastslow.cpp
- 11_detect_cycle.cpp
- 12_merge_sorted.cpp
- 13_remove_duplicates_sorted.cpp
- 14_length.cpp
- 15_nth_from_end.cpp
- 16_sorted_insert.cpp
- 17_split_halves.cpp
- 18_concat_lists.cpp
- 19_map_values.cpp
- 20_summary.cpp

## 05 – Doubly & Circular Linked List
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_dll_create_traverse.cpp
- 02_dll_insert_head.cpp
- 03_dll_insert_tail.cpp
- 04_dll_delete.cpp
- 05_dll_reverse.cpp
- 06_cll_create.cpp
- 07_cll_insert_after.cpp
- 08_cll_delete_next.cpp
- 09_dll_find.cpp
- 10_cll_josephus.cpp
- 11_dll_insert_pos.cpp
- 12_dll_delete_value.cpp
- 13_cll_traverse_n.cpp
- 14_dll_length.cpp
- 15_cll_length.cpp
- 16_dll_concat.cpp
- 17_cll_split.cpp
- 18_dll_find_prev.cpp
- 19_dll_find_next.cpp
- 20_summary.cpp

## 06 – Stack
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_stack_array.cpp
- 02_stack_list.cpp
- 03_paren_match.cpp
- 04_infix_to_postfix.cpp
- 05_postfix_eval.cpp
- 06_stack_peek.cpp
- 07_reverse_string.cpp
- 08_stack_min.cpp
- 09_stack_sort.cpp
- 10_evaluate_prefix.cpp
- 11_balanced_brackets.cpp
- 12_two_stacks.cpp
- 13_stack_using_queue.cpp
- 14_next_greater_element.cpp
- 15_stock_span.cpp
- 16_nearest_smaller_left.cpp
- 17_nearest_smaller_right.cpp
- 18_redundant_brackets.cpp
- 19_duplicate_parentheses.cpp
- 20_summary.cpp

## 07 – Queue
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_queue_array.cpp
- 02_queue_list.cpp
- 03_deque_simple.cpp
- 04_priority_queue_min.cpp
- 05_simulate_scheduling.cpp
- 06_circular_queue.cpp
- 07_queue_reverse.cpp
- 08_queue_two_stacks.cpp
- 09_first_nonrepeating_stream.cpp
- 10_sliding_window_max.cpp
- 11_queue_using_stack.cpp
- 12_hot_potato.cpp

- 13_job_scheduling.cpp
- 14_queue_peek.cpp
- 15_queue_size.cpp
- 16_queue_front_back.cpp
- 17_double_ended_queue.cpp
- 18_priority_queue_max.cpp
- 19_ticket_counter.cpp
- 20_summary.cpp

## 08 – Recursion
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_factorial.cpp
- 02_fibonacci.cpp
- 03_binary_search_rec.cpp
- 04_tower_of_hanoi.cpp
- 05_sum_digits.cpp
- 06_power.cpp
- 07_permutations_string.cpp
- 08_combinations.cpp
- 09_subset_sum.cpp
- 10_n_queens_count.cpp
- 11_gcd.cpp
- 12_lcs_length_rec.cpp
- 13_palindrome_rec.cpp
- 14_reverse_list_rec.cpp
- 15_print_array_rec.cpp
- 16_count_zeros.cpp
- 17_sum_array_rec.cpp
- 18_digit_to_words.cpp
- 19_maze_paths_count.cpp
- 20_summary.cpp

## 09 – Binary Trees & BST
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_bst_insert_traverse.cpp
- 02_bst_search.cpp
- 03_bst_delete.cpp

- 04_pre_in_post.cpp
- 05_height_count.cpp
- 06_level_order_queue.cpp
- 07_is_bst_check.cpp
- 08_lowest_common_ancestor.cpp
- 09_kth_smallest.cpp
- 10_floor_ceil_bst.cpp
- 11_range_sum_bst.cpp
- 12_balanced_check.cpp
- 13_diameter.cpp
- 14_mirror_tree.cpp
- 15_left_view.cpp
- 16_right_view.cpp
- 17_top_view.cpp
- 18_bottom_view.cpp
- 19_boundary_traversal.cpp
- 20_summary.cpp

## 10 – Advanced Trees (AVL, Heap)
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_avl_insert.cpp
- 02_avl_delete.cpp
- 03_heap_min.cpp
- 04_heap_max.cpp
- 05_heap_sort.cpp
- 06_priority_queue_heap.cpp
- 07_k_largest_heap.cpp
- 08_running_median.cpp
- 09_merge_k_sorted_arrays.cpp
- 10_interval_heap.cpp
- 11_treap_insert.cpp
- 12_splay_insert.cpp
- 13_fenwick_tree_point_update.cpp
- 14_segment_tree_range_sum.cpp
- 15_segment_tree_lazy.cpp
- 16_leftist_heap_meld.cpp
- 17_binomial_heap_basic.cpp
- 18_order_statistic_tree_intro.cpp
- 19_kd_tree_concept.cpp
- 20_summary.cpp

## 11 – Graph Basics
### Topics

- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_adj_matrix.cpp
- 02_adj_list.cpp
- 03_bfs.cpp
- 04_dfs.cpp
- 05_cycle_directed.cpp
- 06_cycle_undirected.cpp
- 07_connected_components.cpp
- 08_path_exists.cpp
- 09_graph_input_example.cpp
- 10_graph_print.cpp
- 11_degree_count.cpp
- 12_transpose_digraph.cpp
- 13_bfs_levels.cpp
- 14_dfs_times.cpp
- 15_tree_vs_graph_check.cpp
- 16_is_bipartite_basic.cpp
- 17_bridge_concept.cpp
- 18_articulation_points_concept.cpp
- 19_self_loop_demo.cpp
- 20_summary.cpp

## 12 – Graph Algorithms
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_dijkstra.cpp
- 02_topological_sort.cpp
- 03_mst_kruskal.cpp
- 04_mst_prim.cpp
- 05_bipartite_check.cpp
- 06_bellman_ford.cpp
- 07_floyd_warshall.cpp
- 08_kosaraju_scc.cpp
- 09_tarjan_scc.cpp
- 10_0_1_bfs.cpp
- 11_prim_dense_matrix.cpp
- 12_kruskal_disjoint_set.cpp
- 13_dijkstra_with_parent.cpp
- 14_shortest_path_reconstruction.cpp

- 15_minimum_path_cover_dag.cpp
- 16_longest_path_dag.cpp
- 17_edmonds_karp_concept.cpp
- 18_dinic_concept.cpp
- 19_heuristic_tsp_demo.cpp
- 20_summary.cpp

## 13 – Hashing
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_hash_chaining.cpp
- 02_hash_open_addressing_linear.cpp
- 03_hash_quadratic.cpp
- 04_hash_double.cpp
- 05_hash_string.cpp
- 06_unordered_map_basic.cpp
- 07_count_frequency.cpp
- 08_group_anagrams.cpp
- 09_two_sum_hash.cpp
- 10_lru_cache_concept.cpp
- 11_consistent_hashing_concept.cpp
- 12_rolling_hash_intro.cpp
- 13_rabin_karp_demo.cpp
- 14_set_vs_unordered_set.cpp
- 15_custom_hash_struct.cpp
- 16_hash_load_factor_demo.cpp
- 17_hash_resize_demo.cpp
- 18_hash_collision_demo.cpp
- 19_phonebook_map.cpp
- 20_summary.cpp

## 14 – Review & Practice
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_practice_arrays.cpp
- 02_practice_strings.cpp
- 03_practice_sll.cpp
- 04_practice_dll.cpp
- 05_practice_stack.cpp

- 06_practice_queue.cpp
- 07_practice_recursion.cpp
- 08_practice_bst.cpp
- 09_practice_avl.cpp
- 10_practice_heap.cpp
- 11_practice_graph_bfs.cpp
- 12_practice_graph_dfs.cpp
- 13_practice_dijkstra.cpp
- 14_practice_toposort.cpp
- 15_practice_mst.cpp
- 16_practice_hashing.cpp
- 17_practice_sorting.cpp
- 18_practice_searching.cpp
- 19_practice_mix.cpp
- 20_summary.cpp

## 15 – Sorting & Searching
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity
- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_counting_sort.cpp
- 02_radix_sort.cpp
- 03_bucket_sort_concept.cpp
- 04_heap_sort.cpp
- 05_quick_sort.cpp
- 06_merge_sort.cpp
- 07_shell_sort_concept.cpp
- 08_intro_sort_concept.cpp
- 09_timsort_concept.cpp
- 10_binary_search.cpp
- 11_ternary_search_concept.cpp
- 12_exponential_search.cpp
- 13_interpolation_search.cpp
- 14_lower_upper_bound.cpp
- 15_search_rotated_array.cpp
- 16_kth_smallest_quickselect.cpp
- 17_external_merge_sort_concept.cpp
- 18_stable_unstable_demo.cpp
- 19_inversion_count.cpp
- 20_summary.cpp

## 16 – Applications & Final Project
### Topics
- See CourseBook.md for detailed background
- Key operations, use-cases, complexity

- Pitfalls and best practices
- Using Makefile (handles spaces):
- Using g++ directly:
### Examples
- 01_expr_evaluator_stack.cpp
- 02_student_mgmt_array.cpp
- 03_library_bst.cpp
- 04_router_bfs.cpp
- 05_scheduler_priority_queue.cpp
- 06_lru_cache_list_hash.cpp
- 07_autocomplete_prefix.cpp
- 08_url_shortener_hash.cpp
- 09_social_network_graph.cpp
- 10_event_simulation_queue.cpp
- 11_text_editor_undo_stack.cpp
- 12_image_histogram_array.cpp
- 13_spell_checker_hash.cpp
- 14_file_system_tree.cpp
- 15_navigation_dijkstra.cpp
- 16_median_stream_heap.cpp
- 17_recommendation_graph.cpp
- 18_inventory_system_hash.cpp
- 19_bank_queue_simulation.cpp
- 20_summary.cpp