CSE205: DATA STRUCTURES AND ALGORITHMS

L: 3 T : 0 P : 2 Credits: 4

Course Outcomes: Through this course students should be able to

CO1 :: describe the process to find efficiency of algorithms using asymptotic notations.

CO2 :: develop skills to compare various data structure algorithms.

CO3 :: illustrate the importance of data structures in context of writing efficient programs.

CO4 :: identify appropriate data structures in problem solving.

CO5 :: recommend to improve existing code using learned algorithms and data structures.

CO6 :: construct new solutions for programming problems.

Unit I

Introduction: Basic Data Structures, Basic Concepts and Notations, Complexity analysis: time space and trade off, Omega Notation, Theta Notation, Big O notation

Arrays: Linear arrays: memory representation, Traversal, Insertion, Deletion, Searching, Merging and their complexity analysis.

Sorting and Searching: Bubble sort, Insertion sort, Selection sort

Unit II

Linked Lists: Introduction, Memory representation, Allocation, Traversal, Insertion, Deletion, Header linked lists: Grounded and Circular, Two-way lists: operations on two way linked lists

Unit III

Stacks: Introduction: List and Array representations, Operations on stack (traversal, push and pop), Arithmetic expressions: polish notation, evaluation and transformation of expressions

Queue: Array and list representation, operations (traversal, insertion and deletion), Priority Queues, Deques

Unit IV

Recursion: Introduction, Recursive implementation of Towers of Hanoi, Merge sort, Quick sort
Trees : Binary trees - introduction (complete and extended binary trees), memory representation (linked, sequential), Pre-order traversal, In-order traversal, Post-order traversal using recursion, Binary Search Tree- searching, insertion, deletion

Unit V

AVL trees and Heaps: AVL trees - introduction, AVL trees Insertion, AVL trees Deletion, Heaps - Insertion, Heapify, Deletion, Heap Sort, Huffman algorithm

Unit VI

Graphs: Warshall's algorithm, Shortest path algorithm Floyd Warshall Algorithm (modified Warshall algorithm), Graph Traversal: BFS, DFS

Hashing : Hashing Introduction, Hash Functions, Hash Table, Closed hashing (open addressing), Linear Probing, Quadratic Probing, Double Hashing, Open hashing (separate chaining)

List of Practical:

Arrays: Program to implement insertion and deletion operations in arrays

Searching: Program to implement different searching techniques - linear and binary search

Sorting: Program to implement different sorting techniques – bubble, selection and insertion sort

Linked List: Program to implement searching, insertion and deletion operations in linked list

Doubly Linked List: Program to implement searching, insertion and deletion operations in doubly linked list

Stacks: Program to implement push and pop operations in stacks using both arrays and linked list

Queues: Program to implement enqueue and dequeue operations in queues using both arrays and linked list

Recursions: Program to demonstrate concept of recursions with problem of tower of Hanoi

Recursive Sorting: Program to implement recursive sorting techniques - merge sort, quick sort

Trees: Program to create and traverse a binary tree recursively

Binary Search Tree: Program to implement insertion and deletion operations in BST

Heaps: Program to implement insertion and deletion operations in Heaps and Heap Sort

Text Books:

1. DATA STRUCTURES by SEYMOUR LIPSCHUTZ, MCGRAW HILL EDUCATION

References:

1. DATA STRUCTURES AND ALGORITHMS by ALFRED V. AHO, JEFFREY D. ULLMAN AND JOHN E. HOPCROFT, PEARSON

Lovely Professional University, Punjab

Course Code	Course Title	Course Planner	Lectures	Tutorials	Practicals	Credits
CSE205	DATA STRUCTURES AND ALGORITHMS	16915 :: Md. Ataullah	3	0	2	4
Course Weightage	ATT: 5 CA: 25 MTT: 20 ETT: 50	**Exam Category: 11: Mid Term Exam: All MCQ – End Term Exam: All MCQ**				
Course Orientation	COMPETITIVE EXAMINATION (Higher Education), KNOWLEDGE ENHANCEMENT, PLACEMENT EXAMINATION(Mass Recruiters)					

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CO6 :: construct new solutions for programming problems.

	TextBooks (T)		
Sr No	**Title**	**Author**	**Publisher Name**
T-1	DATA STRUCTURES	SEYMOUR LIPSCHUTZ	MCGRAW HILL EDUCATION

	Reference Books (R)		
Sr No	**Title**	**Author**	**Publisher Name**
R-1	DATA STRUCTURES AND ALGORITHMS	ALFRED V. AHO, JEFFREY D. ULLMAN AND JOHN E. HOPCROFT	PEARSON

Relevant Websites (RW)		
Sr No	**(Web address) (only if relevant to the course)**	**Salient Features**
RW-1	https://www.geeksforgeeks.org/data-structures/	Every data structure explained with the help of demo program
RW-2	http://www.cs.usfca.edu/~galles/visualization/Algorithms.html	Data structures visualization
RW-3	https://www.tutorialspoint.com/data_structures_algorithms/index.htm	Tutorials give a clear understanding of concepts in easy and simplified manner
RW-4	http://www.cs.auckland.ac.nz/software/AlgAnim/huffman.html	Huffman Encoding

Audio Visual Aids (AV)		
Sr No	**(AV aids) (only if relevant to the course)**	**Salient Features**
AV-1	https://freevideolectures.com/subject/data-structures/	Data structures audio video tutorials

Software/Equipments/Databases		
Sr No	**(S/E/D) (only if relevant to the course)**	**Salient Features**
SW-1	Dev C++ /Borland C++/Turbo C++	IDE to implement data structures in convenient and faster way

LTP week distribution: (LTP Weeks)	
Weeks before MTE	7
Weeks After MTE	7
Spill Over (Lecture)	9

Detailed Plan For Lectures

Week Number	Lecture Number	Broad Topic(Sub Topic)	Chapters/Sections ofText/reference books	Other Readings, Relevant Websites, Audio Visual Aids, software andVirtual Labs	Lecture Description	Learning Outcomes	Pedagogical Tool Demonstration/ Case Study / Images / animation / ppt etc. Planned	Live Examples
Week 1	Lecture/ Practical 1	Basic Data Structures	T-1, R-1	RW-1, RW-3	Lecture 0, Introduction to data structures	Remembering basicconcepts and algorithmic notations used in data structures, complexity of algorithms	Lecture cum demonstration, brain storming	Keeping files in a folder, directory structure
	Lecture/ Practical 2	Complexity analysis: time space and trade off,	T-1, R-1	RW-1, RW-3	Applications of different types of data structures and time space trade off	Understanding howto apply suitable data structure for given application	Lecture cum demonstration, brain storming	Moves on chess board
	Lecture/ Practical 3	Omega Notation, Theta Notation, BigO notation	T-1, R-1	RW-1, RW-3	Applications of different types of data structures and time space trade off	Understanding howto apply suitable data structure forgiven application	Lecture cum demonstration, brain storming	Moves on chess board
	Lecture/ Practical 4	Linear arrays: memory representation, Traversal	T-1, R-1	RW-1, RW-3,SW-1	Traversal operation in arrays	Understanding manipulation of elements in an array	Lecture cum demonstration, brain storming	Placing a chair in between a row of chairs
	Lecture/ Practical 5	Linear arrays: Insertion, Deletion	T-1, R-1	RW-1, SW-1	Insertion operation in arrays	Understanding manipulation of elements in an array	Lecture cum demonstration, brain storming	Placing a chair in between a row of chairs

Week 2	Lecture/ Practical 6	Linear arrays: Insertion, Deletion	T-1, R-1	RW-1, SW-1	Deletion operation in arrays	Understanding manipulation of elements in an array	Lecture cum demonstration, brain storming	Removing a chair in between a row of chairs
	Lecture/ Practical 7	Searching and its complexity analysis.	T-1, R-1	RW-1, RW-2,SW-1	Searching (linear search, binary search) element in array	Analyzing how to apply appropriate searching algorithm at appropriate place	Lecture cum demonstration, brain storming	Searching a person sitting in a row of chairs
	Lecture/ Practical 8	Searching and its complexity analysis.	T-1, R-1	RW-1, RW-2,SW-1	Searching (linear search, binary search) element in array	Analyzing how to apply appropriate searching algorithm at appropriate place	Lecture cum demonstration, brain storming	Searching a person sitting in a row of chairs
	Lecture/ Practical 9	Merging and its complexity analysis.	T-1, R-1	RW-1, RW-2,SW-1	Merging elements of arrays	Understanding manipulation of elements in an array	Lecture cum demonstration, brain storming	Merging two sections of a class for giving lecture
	Lecture/ Practical 10	Bubble sort, Insertionsort, Selection sort	T-1, R-1	RW-1, RW-2,SW-1	Sorting elements of array	Analyzing how to apply appropriate sorting algorithm atappropriate place	Lecture cum demonstration, brain storming	Making students sit according to roll-nos. in a row
Week 3	Lecture/ Practical 11	Bubble sort, Insertion sort, Selection sort	T-1, R-1	RW-1, RW-2,SW-1	Sorting elements of array	Analyzing how to apply appropriate sorting algorithm atappropriate place	Lecture cum demonstration, brain storming	Making students sit according to roll-nos. in a row
	Lecture/ Practical 12	Linked Lists: Introduction, Memory representation	T-1, R-1	RW-1, RW-3,SW-1	Introduction to linked list and its creation	Understanding linked representationof memory and dynamic allocation	Lecture cum demonstration, brain storming	Chain, slides management in presentation.
	Lecture/ Practical 13	Linked Lists: Allocation, Traversal	T-1, R-1	RW-1, RW-3,SW-1	Introduction to linked list and its creation	Understanding linked representationof memory and dynamic allocation	Lecture cum demonstration, brain storming	Chain, slides management in presentation.
	Lecture/ Practical 14	Linked Lists: Insertion	T-1, R-1	RW-1, SW-1	Introduction to linked list and its creation	Understanding linked representationof memory and dynamic allocation	Lecture cum demonstration, brain storming	Chain, slides management in presentation.
	Lecture/ Practical 15	Linked Lists: Insertion	T-1, R-1	RW-1, SW-1	Introduction to linked list and its creation	Understanding linked representationof memory and dynamic allocation	Lecture cum demonstration, brain storming	Chain, slides management in presentation.

Week 4	Lecture/ Practical 16	Linked Lists: Deletion	T-1, R-1	RW-1, SW-1	Algorithm to traverse and delete nodes in linked list	Understanding linked representationof memory and dynamic allocation	Lecture cum demonstration, brain storming	Chain, slides management in presentation.
	Lecture/ Practical 17	Linked Lists: Deletion	T-1, R-1	RW-1, SW-1	Algorithm to traverse and delete nodes in linked list	Understanding linked representationof memory and dynamic allocation	Lecture cum demonstration, brain storming	Chain, slides management in presentation.
	Lecture/ Practical 18	Header linked lists:Grounded and Circular	T-1, R-1	RW-1, SW-1	Different variant of linked list	Analyzing modification in the design of linked list to increase efficiency	Lecture cum demonstration, brain storming	Arrangemen t of coaches of a train
	Lecture/ Practical 19	Header linked lists:Grounded and Circular	T-1, R-1	RW-1, SW-1	Different variant of linked list	Analyzing modification in the design of linked listto increase efficiency	Lecture cum demonstration, brain storming	Arrangemen t of coaches of a train
	Lecture/ Practical 20	Header linked lists:Grounded and Circular	T-1, R-1	RW-1, SW-1	Different variant of linked list	Analyzing modification in the design of linked list to increase efficiency	Lecture cum demonstration, brain storming	Arrangemen t of coaches of a train
Week 5	Lecture/ Practical 21	Two-way lists: operations on twoway linked lists	T-1, R-1	RW-1, SW-1	Different variant of linked list	Analyzing modification in the design of linked list to increase efficiency	Lecture cum demonstration, brain storming	Arrangemen t of coaches of a train
	Lecture/ Practical 22	Two-way lists: operations on twoway linked lists	T-1, R-1	RW-1, SW-1	Different variant of linked list	Analyzing modification in the design of linked list to increase efficiency	Lecture cum demonstration, brain storming	Arrangemen t of coaches of a train
	Lecture/ Practical 23				Online Assignment			
	Lecture/ Practical 24	Stacks: Introduction:List and Array representations, Operations on stack (traversal, push and pop)	T-1, R-1	RW-1, RW-2,SW-1	Representing stack using linked list and array, push and pop operations	Understanding implementation of stack using array andlinked list as per LIFO arrangement	Lecture cum demonstration, brain storming	Navigation of directory structure in windows
	Lecture/ Practical 25	Stacks: Introduction: List and Array representations, Operations on stack	T-1, R-1	RW-1, RW-2,SW-1	Representing stack using linked list and array, push and pop operations	Understanding implementation of stack using array andlinked list as per LIFO arrangement	Lecture cum demonstration, brain storming	Navigation of directory structure in windows

		(traversal, push and pop)						
Week 6	Lecture/ Practical 26	Stacks: Introduction:List and Array representations, Operations on stack (traversal, push and pop)	T-1, R-1	RW-1, RW-2,SW-1	Representing stack using linked list and array, push and pop operations	Understanding implementation of stack using array andlinked list as per LIFO arrangement	Lecture cum demonstration, brain storming	Navigation of directory structure in windows
	Lecture/ Practical 27	Arithmetic expressions: polishnotation	T-1, R-1	RW-1, SW-1	Stack representation of arithmetic expressions expression using stack	Understanding prefix, infix and postfix notations preparation	Lecture cum demonstration, brain storming	Compiler design
	Lecture/ Practical 28	Evaluation and transformation of expressions	T-1, R-1	RW-1, SW-1	Evaluation and transformation of infix to postfix expression using stack	Understanding evaluation and transformation of infix to postfix expression using stack	Lecture cum demonstration, brain storming	Compiler design
	Lecture/ Practical 29	Queue: Array and listrepresentation, operations (traversal, insertion anddeletion)	T-1, R-1	RW-1, RW-2,SW-1	Representation of queue using arrays and linked list and operations	Understanding memory management as per FIFO arrangement	Lecture cum demonstration, brain storming	Process scheduling algorithms
	Lecture/ Practical 30	Queue: Array and listrepresentation, operations (traversal, insertion and deletion)	T-1, R-1	RW-1, RW-2,SW-1	Representation of queue using arrays and linked list and operations	Understanding memory management as per FIFO arrangement	Lecture cum demonstration, brain storming	Process scheduling algorithms
Week 7	Lecture/ Practical 31	Queue: Array and listrepresentation, operations (traversal, insertion and deletion)	T-1, R-1	RW-1, RW-2,SW-1	Representation of queue using arrays and linked list and operations	Understanding memory management as per FIFO arrangement	Lecture cum demonstration, brain storming	Process scheduling algorithms
	Lecture/ Practical 32	Priority Queues	T-1, R-1	RW-1, SW-1	Different versions of queue and its operations	Understanding memory management as per FIFO arrangement	Lecture cum demonstration, brain storming	Process scheduling algorithms
	Lecture/ Practical 33	Deques	T-1, R-1	RW-1, SW-1	Different versions of queue and its operations	Understanding memory management as per FIFO arrangement	Lecture cum demonstration, brain storming	Process scheduling algorithms

SPILL OVER

	Lecture/ Practical 34			AV-1	Spill Over			
	Lecture/ Practical 35			AV-1	Spill Over			
MID-TERM								
Week 8	Lecture/ Practical 36	Recursion: Introduction, Recursive implementation of Towers of Hanoi	T-1, R-1	RW-1, SW-1	Introduction of recursion and problem of tower of Hanoi	Using recursive solutions for different problems	Lecture cum demonstration, brain storming	Container loading and unloading
	Lecture/ Practical 37	Recursion: Merge sort	T-1, R-1	RW-1, SW-1	Algorithm of merge sort using recursive method	Using recursive solutions for different problems	Lecture cum demonstration, brain storming	
	Lecture/ Practical 38	Recursion: Merge sort	T-1, R-1	RW-1, SW-1	Algorithm of merge sort using recursive method	Using recursive solutions for different problems	Lecture cum demonstration, brain storming	
	Lecture/ Practical 39	Recursion: Quick sort	T-1, R-1	RW-1, SW-1	Algorithm of Quick sort using recursive method	Using recursive solutions for different problems	Lecture cum demonstration, brain storming	
	Lecture/ Practical 40	Recursion: Quick sort	T-1, R-1	RW-1, SW-1	Algorithm of Quick sort using recursive method	Using recursive solutions for different problems	Lecture cum demonstration, brain storming	
Week 9	Lecture/ Practical 41	Trees: Binary trees - introduction (complete and extended binary trees), memory representation (linked, sequential)	T-1, R-1	RW-1, SW-1	Introduction to tree data structure and its memory representation	Remembering nonlinear memory arrangements and its applications	Lecture cum demonstration, brain storming	Directory structure and file system, Web site link structure
	Lecture/ Practical 42	Trees : Binary trees -introduction (complete and extended binary trees), memory representation (linked, sequential)	T-1, R-1	RW-1, SW-1	Introduction to tree data structure and its memory representation	Remembering nonlinear memory arrangements and its applications	Lecture cum demonstration, brain storming	Directory structure and file system, Web site link structure
	Lecture/ Practical 43	Trees: Pre-order traversal, In-order traversal, Post-ordertraversal using recursion	T-1, R-1	RW-1, SW-1	Tree traversal basics and pre-order tree traversal algorithm	Understanding node to node access	Lecture cum demonstration, brain storming	Directory structure and file system, Web site link structure

	Lecture/ Practical 44	Trees: Pre-order traversal, In-order traversal, Post-order traversal usingrecursion	T-1, R-1	RW-1, SW-1	Tree traversal basics and pre-order tree traversal algorithm	Understanding node to node access	Lecture cum demonstration, brain storming	Directory structure and file system, Web site link structure
	Lecture/ Practical 45	Binary Search Tree-insertion	T-1, R-1	RW-1, RW-2, SW-1	Introduction to binary search tree	Understanding arrangement of data efficiently	Lecture cum demonstration, brain storming	Directory structure and file system, Web site link structure
Week 10	Lecture/ Practical 46	Binary Search Tree-searching,	T-1, R-1	RW-1, RW-2, SW-1	Insertion of nodes and its algorithm in binary search tree	Understanding arrangements of data after manipulations	Lecture cum demonstration, brain storming	Directory structure and file system, Web site link structure
	Lecture/ Practical 47	Binary Search Tree-deletion	T-1, R-1	RW-1, RW-2, SW-1	Deletion of nodes and its algorithm in binary search tree	Understanding arrangements of data after manipulations	Lecture cum demonstration, brain storming	Directory structure and file system, Web site link structure
	Lecture/ Practical 48				Online Assignment			
	Lecture/ Practical 49	AVL trees - introduction	T-1, R-1	RW-1, RW-2, SW-1	Introduction to AVL trees and insertion	Applying another requirement to make more efficient arrangement of data in nonlinear data structure	Lecture cum demonstration, brain storming	
	Lecture/ Practical 50	AVL trees Insertion	T-1, R-1	RW-1, RW-2, SW-1	Introduction to AVL trees and insertion	Applying another requirement to make more efficient arrangement of data in nonlinear data structure	Lecture cum demonstration, brain storming	
Week 11	Lecture/ Practical 51	AVL trees Deletion	T-1, R-1	RW-1, RW-2, SW-1	Deletion in AVL tree	Applying another requirement to make more efficient arrangement of data in nonlinear data structure	Lecture cum demonstration, brain storming	
	Lecture/ Practical 52	Heaps - Insertion, Heapify	T-1, R-1	RW-1, RW-2, SW-1	Introduction to heap, insertion and deletion algorithm, Heap sort	Understanding array representation of trees	Lecture cum demonstration, brain storming	

	Lecture/ Practical 53	Heaps - Insertion, Heapify	T-1, R-1	RW-1, RW-2, SW-1	Introduction to heap, insertion and deletion algorithm, Heap sort	Understanding array representation of trees	Lecture cum demonstration, brain storming	
	Lecture/ Practical 54	Heaps - Deletion	T-1, R-1	RW-1, RW-2, SW-1	Introduction to heap, insertion and deletion algorithm, Heap sort	Understanding array representation of trees	Lecture cum demonstration, brain storming	
	Lecture/ Practical 55	Heaps - Heap Sort	T-1, R-1	RW-1, RW-2, SW-1	Introduction to heap, insertion and deletion algorithm, Heap sort	Applying array representation of trees	Lecture cum demonstration, brain storming	
Week 12	Lecture/ Practical 56	Huffman algorithm	T-1, R-1	RW-4	Compression algorithm for different strings	Applying technique for efficient use of resources to arrange	Lecture cum demonstration, brain storming	Compression in Fax machine
	Lecture/ Practical 57	Huffman algorithm	T-1, R-1	RW-4	Compression algorithm for different strings	Applying technique for efficient use of resources to arrange	Lecture cum demonstration, brain storming	Compression in Fax machine
	Lecture/ Practical 58	Graphs: Warshall's algorithm	T-1, R-1	RW-1, SW-1	Operations on graphs and shortest path algorithm	Understanding node to node movement within graphs	Lecture cum demonstration, brain storming	Maps and Navigation
	Lecture/ Practical 59	Graphs: Warshall's algorithm	T-1, R-1	RW-1, SW-1	Operations on graphs and shortest path algorithm	Understanding node to node movement within graphs	Lecture cum demonstration, brain storming	Maps and Navigation
	Lecture/ Practical 60	Shortest path algorithm: Floyd Warshall Algorithm (modified Warshall algorithm)	T-1, R-1	RW-1, SW-1	Operations on graphs and shortest path algorithm	Understanding node to node movement within graphs	Lecture cum demonstration, brain storming	Maps and Navigation
Week 13	Lecture/ Practical 61	Shortest path algorithm: Floyd Warshall Algorithm (modified Warshall algorithm)	T-1, R-1	RW-1, SW-1	Operations on graphs and shortest path algorithm	Understanding node to node movement within graphs	Lecture cum demonstration, brain storming	Maps and Navigation
	Lecture/ Practical 62	Graph Traversal:BFS, DFS	T-1, R-1	RW-1, SW-1	Operations on graphs and shortest path algorithm	Understanding node to node movement within graphs	Lecture cum demonstration,	Maps and Navigation
	Lecture/ Practical 63	Graph Traversal:BFS, DFS	T-1, R-1	RW-1, SW-1	Operations on graphs and shortest path algorithm	Understanding node to node movement within graphs	Lecture cum demonstration, brain storming	Maps and Navigation
	Lecture/ Practical 64				Online Assignment			
	Lecture/ Practical 65	Hashing : Hashing Introduction, Hash Functions, Hash Table	T-1, R-1	RW-1	Hashing techniques and collision detection	Applying efficient searching	Lecture cum demonstration, brain storming	Dictionary lookup and security algorithms

Week 14	Lecture/ Practical 66	Closed hashing (openaddressing)	T-1, R-1	RW-1	Hashing techniques and collision detection	Applying efficient searching	Lecture cum demonstration, brain storming	Dictionary lookup and security algorithms
	Lecture/ Practical 67	Linear Probing, Quadratic Probing,Double Hashing	T-1, R-1	RW-1	Hashing techniques and collision detection	Applying efficient searching	Lecture cum demonstration, brain storming	Dictionary lookup and security algorithms
	Lecture/ Practical 68	Open hashing (separate chaining)	T-1, R-1	RW-1	Hashing techniques and collision detection	Applying efficient searching	Lecture cum demonstration, brain storming	Dictionary lookup and security algorithms
SPILL OVER								
	Lecture/ Practical 69			AV-1	Spill Over			
	Lecture/ Practical 70			AV-1	Spill Over			
Week 15	Lecture/ Practical 71			AV-1	Spill Over			
	Lecture/ Practical 72			AV-1	Spill Over			
	Lecture/ Practical 73			AV-1	Spill Over			
	Lecture/ Practical 74			AV-1	Spill Over			
	Lecture/ Practical 75			AV-1	Spill Over			

Scheme for CA:

CA Category of this Course Code is: A0203 (2 best out of 3)

Component	Weightage (%)
Online Assignment	50
Online Assignment	50
Online Assignment	50

Details of Academic Task(s)

Academic Task	Objective	Detail of Academic Task	Nature of Academic Task	Mode of Academic Task	Marks	Allotment week/Submission Week
Online Assignment	To evaluate progress of individual student based upon basic data structures implementation and complexity	Multiple choice questions with mix of analytic and descriptive type as per the contents delivered	Individual	Online	30	Week 4/Week 5
Online Assignment	To evaluate progress of individual student based upon applicability of learned concepts	Multiple choice questions with mix of analytic and descriptive type as per the contents delivered	Individual	Online	30	Week 9/Week 10
Online Assignment	To evaluate progress of individual student based upon applicability of learned concepts	Multiple choice questions with mix of analytic and descriptive type as per the contents delivered	Individual	Online	30	Week 12/Week 13