	Course Name:	Artificial Intelligence	Course Code:	CS 401
	Program:	BS (Computer Science)	Semester:	Spring 2019
	Duration:	180 Minutes	Total Marks:	40
	Paper Date:	23-7-2019	Weight	40
	Section:	Retake Exam	Page(s):	
	Exam Type:	Final		

Student Name:
Registration #:

Instructions Calculators: Allowed

Q1. Search Algorithms: **(2 + 2 + 6 Points) [Estimated Time 25 Min]**

Given a list of **n** cities **{C_1, C_2, … , C_n}** a route is a sequence of **n** distinct cities Ci_1, Ci_2, … Ci_n starting at city Ci_1 going to city Ci_2 and ending at city Ci_n. Cost of a route is sum of the costs between successive cities and finally cost of coming back from city Ci_n to city Ci_1.

The travelling salesman problem (TSP) asks the following question:

Given a list of **n** cities **{C_1, C_2, … , C_n}** and the distances between each pair of cities, what is the shortest possible route that starts at some city, visits each city exactly once and returns to the origin city?

In this question we are going to use Hill climbing strategy (i.e. a local search algorithm) to find a optimal/sub-optimal solution of a TSP problem.

Part a) How many different possible ways are there to start at some city and then visit each city exactly once and return to the origin city for a problem of size n (i.e. n cities)? **[2 Point]**

To get full marks give a brief justification of your answer as well

A solution to TSP is a permutation (ordering) of city ids and can be represented as a sequence of city ids stored in an array of array of size n

A simple operator to generate a new solution from an existing solution can be defined as follows

PICK TWO CITIES AT RANDOM AND SWAP THEIR POSITION IN THE SEQUENCE

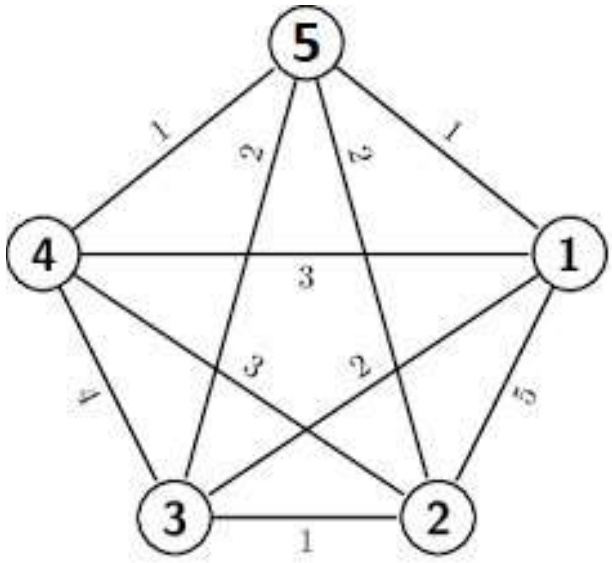
Part b) How Many New Solutions can be generated from an existing solution using this simple operator? Give Reason **[2 Points]**

As defined earlier, the cost of a solution $S_i = (Ci_1, Ci_2, \ldots, Ci_n)$ is the sum of distances between consecutive cities i.e.

$$COST(S_i) = d(Ci_1, Ci_2) + d(Ci_2, Ci_3) + \ldots + d(Ci_{n-1}, Ci_n) + d(Ci_n, Ci_1)$$

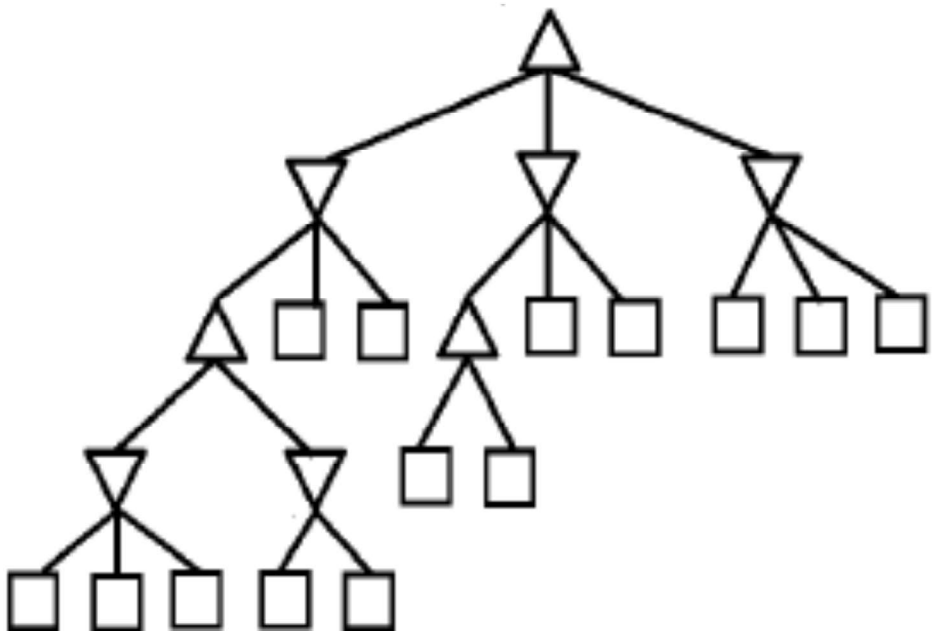
Part c) For the following graph consisting of five cities, use hill climbing algorithm with the method of generating successors as given above to find an optimal solution of the problem using the following randomly generated solution as your initial solution. **1, 3, 4, 2, 5** **[6 Points]**

You must show all intermediate steps



Q 3. Minimax: **(8 Points) [Estimated Time 20 Min]**

Consider the two game trees shown below. For each of the graphs shown below you must **specify the values of utility function** for each of the terminal node (square nodes) that will cause the minimax algorithm prune the indicated branches.

No Pruning	
Pruning