

**Instructions:**

- Do not use pencil

- Total marks: 100

PART 1: Theory (20 Points) **14**

1) ✓	Which is a concern about AI a) It could eliminate some jobs c) It could be used for criminal actions	b) It may control humans at some point in the future d) All answers are correct
2) ✗	Which can NOT be considered as performance measure for Autonomous Taxi: a) Travel time    b) Cameras	c) Profit    d) Safty
3) ✓	Which is NOT considered an AI applications: a) Car plate recognition c) Fruits quality check	b) QR reading d) Tumor detection from medical images
4) ✗	Which of the following best describes an agent's behavior? a) Perception sequence c) Sensors and Actuators	b) Agent function d) Environment in which the agent operates
5) ✓	What determines agent's rationality at a given moment? a) The performance measure c) The actions accessible to the agent	b) The agent's prior knowledge of the environment d) All of the above options. ✓
6) ✓	Which of the following best describes the crossword puzzle environment? a) Multi-agent c) Fully Observable ✓	b) Partially Observable d) Dynamic
7) ✓	Which agent type has the problem generator component? a) Learning agent c) Reflex agent	b) All model-based agents d) All utility-based agents
8) ✗	Which AI approach uses insights from psychology to build models that explain human behavior? a) Systems that think humanly c) Systems that think rationally ✓	b) Systems that act humanly d) Systems that act rationally
9) ✓	Which field of AI involves building systems that can communicate with human? a) Machine learning c) Computer vision	b) Robotics d) Natural language processing
10) ✓	Which type of agent uses a performance measure to evaluate how well it is achieving its goals? a) Simple reflex agents c) Goal-based agents	b) Model-based reflex agents d) Utility-based agents



PART 2: Problem solving (15 Points)

a) MCQ (8 Points)

1)	In which case does BFS give optimal solution: a) When action costs are decreasing with depth b) When action costs are increasing with depth c) When action costs are identical d) When the goal state differs from the initial state
2)	Which is true about search cost (S) and path cost (P)? a) S measures the time required to find solution, while P measures the cost to execute it b) S is measured in terms of number of nodes, while P is measured in other units c) Both (a) and (b) are correct d) No answer is correct
3)	You have tested a new algorithm A on one test case T. You noticed that A found sub-optimal solution of T. What could be concluded? a) A is not optimal b) A is complete c) A is not optimal nor complete d) A may be complete but not be optimal
4)	Problem formulation does not include writing: a) Initial state b) Successor function c) Goal test function d) Error mask function

b) Problem formulation (7 Points)

Three jealous husbands: Three couples (husband and wife) wish to cross a river. They have only one boat that can carry at most 2 people. The husbands are so jealous that none is willing to allow their wife to be with another man if they themselves are not present.

If the state is represented using a vector of length 7  $[h_1, w_1, h_2, w_2, h_3, w_3, b]$  of 0/1 ( $h_1$  is husband #1,  $w_1$  is wife #1, and  $b$  is the boat). A value of 0 indicate being at the original side of the river, while a value of 1 indicate being at the target side. Thus, initial state is  $[0, 0, 0, 0, 0, 0, 0]$  and the goal state is  $[1, 1, 1, 1, 1, 1, 1]$ .

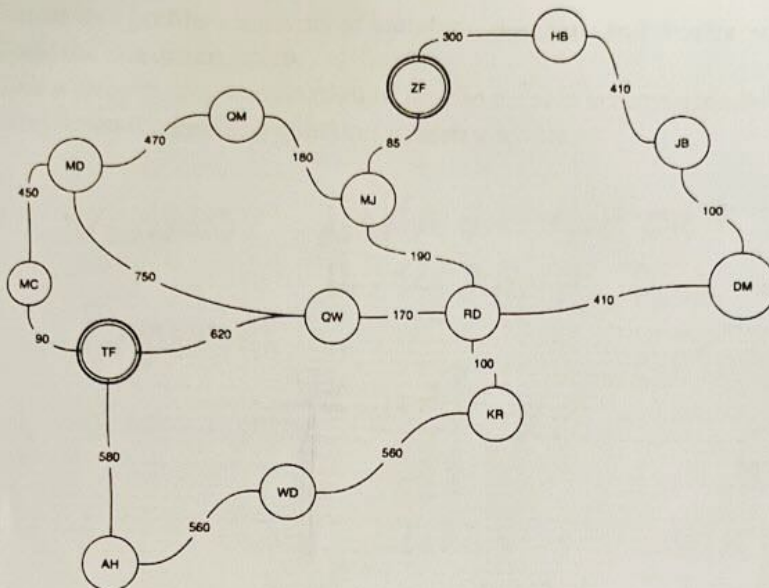
While developing the successor function, you need to validate each successor. The function `isValid` accepts a state and returns true if and only if the given state conforms with the conditions of the problem. Write the function `isValid`:

Boolean Function `isValid(state S[h1,w1, h2,w2, h3,w3, b])`



### PART 3: Blind/Informed search (25 Points) Φ

Consider the given graph, the objective is to reduce cost. Initial state is ZF and goal state is TF. Fill in the table below (break ties alphabetically, do not permit immediate repeated states):



State	<i>h</i>
TF	0
MC	80
AH	550
QW	600
MD	500
QM	950
MJ	950
RD	700
KR	790
WD	1050
DM	1100
ZF	1060
JB	1160
HB	1200

	Strategy	Solution path	Search cost (# of nodes generated)
a)	BFS		$O(b^{d+1})$
b)	UCS	<del>ZF, MJ, QM, MD, MC, TF</del>	$O(b^d)$
c)	DFS	<del>ZF, HB, JB, BM, RD, WD, AH, TF</del>	$O(b^m)$
d)	IDS	<del>ZF, HB, JB, BM, RD, WD, AH, TF</del>	$O(b^l)$
e)	Greedy	<del>MJ, R, ZF, RD, QM, TF</del>	$O(b^m)$
f)	A*		

### Part 4: Local search (20 Points) 7

A genetic algorithm uses a 5-bit string  $B = [b_4 \ b_3 \ b_2 \ b_1 \ b_0]$  to represent each individual, and a fitness function  $f(B) = (b_4 + b_3 + b_2 + b_1 + b_0) + (b_4 \wedge b_3 \wedge b_2 \wedge b_1 \wedge b_0)$  where  $\wedge$  means the logical AND operator.

1. Given the following individuals, fill the table with their fitness values, and probability of selecting each of them if the selection probability is proportional to the fitness:

Individual	Fitness	Selection Probability
00101	25	6.02%
11101	29	34.93%
00000	0	0%
10010	18	21.68%
11111	31	37.34%

2. Using a single crossover point, if the chosen point is between  $b_3$  and  $b_4$ , show the offspring that will result from mating the parents: 00101 and 10111, and find their fitness values

3. Child 1: 10101, fitness = 21  
 Child 2: 00111, fitness = 7

Part 5: CSP (20 Points) 2K+1

Your task is to find an odd integer of five digits in which each digit, except for the most significant one, is greater than digit to its left. No digit can be zero or greater than five.

1. Define this problem in terms of variables, domains, and constraints.

2. Draw the constraint graph.

3. Give a step-by-step explanation of how to enforce arc consistency using AC-3 algorithm, then write down the updated domain for each variable.

1) Variables: ~~digits in the odd integer~~  
 $D_5, D_4, D_3, D_2, D_1$  ; digits in an integer

Domain:

$D_5: \{4\}$

$D_4: \{3\}$

$D_3: \{2\}$

$D_2: \{1\}$

$D_1: \{1, 2, 3, 4, 5\}$

Constraints:  $D_5 > D_4 > D_3 > D_2$   
 $D_1 \geq D_2$

2)

