CS 540, HW2 Solution, Spring 2010

Problem 1

1. BFS is complete in general. BFS is optimal in this case, because edge costs are 1.
2. DFS is not complete, because the search space is infinite. DFS is not optimal; for example, if the start state is $(0,0)$ and the goal state is $(2,1)$, then $(0,0) \to (2,1)$ is an optimal path, but BFS could find $(0,0) \to (-1,2) \to (1,3) \to (2,1)$.
3. The Manhattan distance heuristic is not admissible. For example, say the goal state is (0,0). Let s be the state (2,1). Denote the heuristic by h and the true cost to the goal by h^*. Then $h(s) = |2-0| + |1-0| = 3 \not\leq 1 = h^*(s)$.
4. Yes, the heuristic

$$h(s) = \begin{cases} 0 & \text{if } s \text{ is a goal node} \\ 1 & \text{otherwise.} \end{cases}$$

is consistent, since for any state s and successor s', we have $h(s) \leq 1 \leq 1 + h(s') = c(s,s') + h(s')$, where $c(s,s') = 1$ denotes the cost of moving from s to s'.

Problem 2.

1. The goal state G_3 is reached after expanding the states S A B C D E G_3. Details:

Pop	Expand?	Queue
S	Y	A B
A	Y	B ; B C D
B	Y	B C D ; D E G_3
B	N	C D ; D E G_3
C	Y	D ; D E G_3 ; S
D	Y	D E G_3 ; S ; G_1 G_2
D	N	E G_3 ; S ; G_1 G_2
E	Y	G_3 ; S ; G_1 G_2 ; D
G_3	Y	

2. The goal state G_1 is reached after expanding the states S A B D G_1. Details:

Pop	Expand?	Queue
S	Y	A B
A	Y	B C D ; B
B	Y	D E G_3 ; C D ; B
D	Y	G_1 G_2 ; E G_3 ; C D ; B
G_1	Y	

(We also accepted G_2 as the goal state reached.)

3. The goal state G_3 is reached after expanding the states S A B in the first iteration and S A B C D B E G_3 in the second iteration. Details:

Iter	Pop	Expand?	Queue (length of path from S)
1	S	Y	A (1) B (1)
	A	Y*	B (1)
	B	Y*	
2	S	Y	A (1) B (1)
	A	Y	B (2) C (2) D (2) ; B (1)
	B	Y*	C (2) D (2) ; B (1)
	C	Y*	D (2) ; B (1)
	D	Y*	B (1)
	B	Y	D (2) E (2) G_3 (2)
	D	N	E (2) G_3 (2)
	E	Y*	G_3 (2)
	G_3	Y	

(*Because the maximum path length is reached, no successors are added, and the state is not added to the closed list. We accepted several variations on this answer.)

4. The goal state G_2 is reached after expanding the states S A C D G_2. Details:

Pop	Expand?	Queue ($g + h$)
S	Y	A $(1 + 10 = 11)$ B $(7 + 23 = 30)$
A	Y	C $((1 + 1) + 1 = 3)$ D $((1 + 15) + 3 = 19)$ B $((1 + 2) + 23 = 26)$ B $(7 + 23 = 30)$
C	Y	D $((1 + 15) + 3 = 19)$ B $((1 + 2) + 23 = 26)$ B $(7 + 23 = 30)$ S $((1 + 1 + 2) + 100 = 104)$
D	Y	G_2 $((1 + 15 + 3) + 0 = 19)$ G_1 $((1 + 15 + 5) + 0 = 21)$ B $((1 + 2) + 23 = 26)$ B $(7 + 23 = 30)$ S $((1 + 1 + 2) + 100 = 104)$
G_2	Y	