Solver: Jesslyn Chew

1) a) i) False [It is possible for the DFS space complexity to be bigger than BFS, when b =1 and d = 5. DFS space complexity = bd = 5, BFS space complexity = b^d = 1]

ii) True

iii) True [It is basically UCS]

iv) True

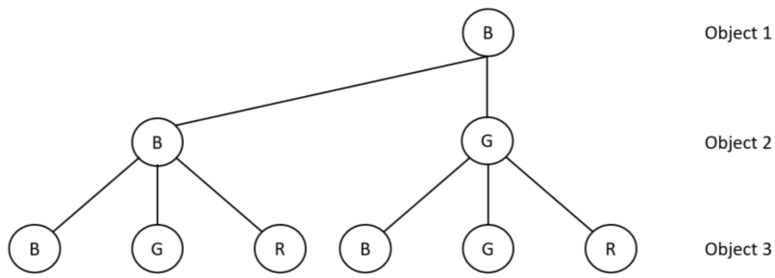
v) False [Although higher is better, it stills need to fulfill the restrictions of a heuristic. The restriction states that the heuristic value must underestimate or be equal to the actual cost.]

b) <u>States:</u> We need to keep track of the visited hotspot, the current location of the UAV and the time of travel. Hence, we need the following variables:

X to represent visited, O to represent not visited. A list to track whether each hotspot is visited. A variable to indicate the current location and a time variable. <u>Initial state:</u> [O, O, …, O] where the i^{th} index is the $(1+i)^{th}$ hotspot. Current location = -1 to represent the base (Let start location = i where i ≠ -1 be the hotspot index). Time = 0. <u>Goal test:</u> visited list = [X, X, …, X] where all hotspots are visited. Current location = -1. Time is the lowest possible value.

<u>Operators:</u> Move to i^{th} hotspot with time x – set the $(i-1)^{th}$ index to X in the visited list, add x to time and current location to (i-1). Move to base with time y – set current location to -1 and add y to time.

c) Constraint propagation is the idea of propagating the implications of a constraint on one variable onto other variables. This results in expanding nodes only if they do not violate the constraint. This can improve search efficiency by minimizing the expansion. For example, let there be 3 objects and 3 different colours. The objective is to have a combination of colours for the 3 unique objects, where the constraint is that the colour must be different. If constraint propagation is used, the nodes explored is would be a maximum of 3 as it prevents expanding nodes that don't follow the requirements. Whereas without the constraint propagation, the best case is 3 as well. However, if we assume the assignment of colours is in alphabetical order (Blue, Green, Red). Then the number of expansions is much more than 3. The diagram below shows a potential expansion tree (using DFS).



Therefore, the constraint propagation improves search efficiency.

d) Best Initial move is B
A = 13, B = 13, C = 12, D = 13, E = 31, F = 12, G = 35, H = 13, I = 12

2) a) Expansion order: A, B, C, D, F, E, G
Final path order: A, B, D, G

b) Expansion order: A, B, C, D, E, G
Final path order: A, B, C, D, E, G

c) Expansion order: A (0), B (1), C (2), D (4), F (7), E (12), G (13)
Final path order: A, B, C, D, G

d) Expansion order: A (10), C (8), F (4), D (7), G (0)
Final path order: A, C, D, G

e) Expansion order: A (10 + 0 = 0), B (9 + 1 = 10), C (8 + 2 = 10), D (7 + 4 = 11), F (4 + 7 = 11), G (9 + 4 = 13)
Final path order: A, B, C, D, G

3) a) i) True
ii) False
iii) False
iv) True
v) False

b) i)
$$LHS \equiv \neg(A \Rightarrow B)$$
$$\equiv \neg(\neg A \vee B)$$
$$\equiv A \wedge \neg B$$
$$\equiv RHS$$

ii)

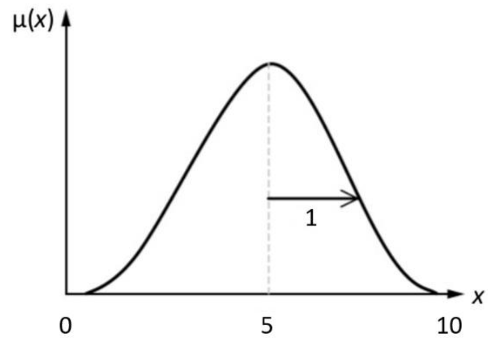
A	**B**	$\mathbf{A \Rightarrow B}$	$\neg(\mathbf{A \Rightarrow B})$	$\mathbf{A \wedge \neg B}$
F	F	T	F	F
F	T	T	F	F
T	F	F	T	T
T	T	T	F	F

iii) The binary operation is an AND operator.

x_1	x_2	h(x)
0	0	S (-30 + 0 + 0) ≈ 0
0	1	S (-30 + 20 + 0) = S (-10) ≈ 0

1	0	S (-30 + 0 + 20) = S (-10) ≈ 0
1	1	S (-30 + 20 + 20) = S (10) ≈ 1

iv)



c) i) Let A be Andy works hard, B be Andy is smart, and C be Andy passes the subject

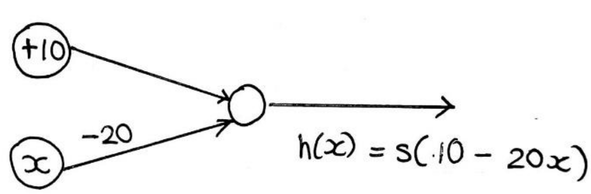
$A \wedge B \Rightarrow C$ (1)
A (2)
B (3)
Since (2) and (3), $\models A \wedge B$ (4)
Since (1) and (4), $\models C$ (5)
Therefore, it is proven that **Andy passes the subject** since C is true.

ii) Using (1) – (3) from the previous question.

$\neg C$ from refutation (4)
From (1), $\neg(A \wedge B) \vee C \equiv \neg A \vee \neg B \vee C$ (5)
From (2) and (5), $\models \neg B \vee C$ (6)
From (3) and (6), $\models C$ (7)
From (4) and (7), $\models \emptyset$
Since there is a contradiction, it is true that **Andy passes the subject**.

4) a) If speed is fast and distance is near, the brake is hard.
If speed is fast and distance is far, the brake is moderate.
If speed is slow and distance is far, the brake is gentle.
If speed is slow and distance is near, the brake is gentle.

b)



x	h(x)
0	s (10) ≈ 1
1	s (10 – 20) s (-10) ≈ 0

c) i) All teachers love their students.

ii) Lazy students fail.

d) i)

$\forall x, y, \neg Payticket(x, y) \Rightarrow Home(x)$ (1)

$\forall x, y, \neg Payticket(x, y) \Rightarrow Poor(y)$ (2)

$\forall x, y, Unhappy(x) \Rightarrow \neg Payticket(x, y)$ (3)

$\forall x, y, Fans(x, y) \wedge Lose(y) \Rightarrow Unhappy(x)$ (4)

$Lose(Chelsea)$ (5)

$Fans(John, Chelsea)$ (6)

From (1), (2) $\vDash SUBST\left(\left\{\frac{x}{John}, \frac{y}{Chelsea}\right\}, Fans(x, y) \wedge Lose(y) \Rightarrow Unhappy(x)\right)$

$\equiv Fans(John, Chelsea) \wedge Lose(Chelsea) \Rightarrow Unhappy(John)$

$\vDash Unhappy(John)$ (7)

From (3),(7) $\vDash SUBST\left(\left\{\frac{x}{John}, \frac{y}{Chelsea}\right\}, Unhappy(x) \Rightarrow \neg Payticket(x, y)\right)$

$\equiv Unhappy(John) \Rightarrow \neg Payticket(John, Chelsea)$

$\vDash \neg Payticket(John, Chelsea)$ (8)

From (1), (8)) $\vDash SUBST\left(\left\{\frac{x}{John}, \frac{y}{Chelsea}\right\}, \neg Payticket(x, y) \Rightarrow Home(x)\right)$

$\equiv \neg Payticket(John, Chelsea) \Rightarrow Home(John)$

$\vDash \boldsymbol{Home(John)}$ (9)

From the following, we can deduce that John is at home as Home(John) is true.

ii) Refer to statement 1-8 in the previous question.

From (2), (8)) $\vDash SUBST\left(\left\{\frac{x}{John}, \frac{y}{Chelsea}\right\}, \neg Payticket(x, y) \Rightarrow Poor(y)\right)$

$\equiv \neg Payticket(John, Chelsea) \Rightarrow Poor(Chelsea)$

$\vDash \boldsymbol{Poor(Chelsea)}$ (9)

From the following, we can deduce that Chelsea is poor as Poor(Chelsea) is true.

iii) Resolution by refutation can solve entailed sentences that resolution inference cannot prove. For example, empty knowledge base, KB $\vDash P \vee \neg P$

--End of Answers--