Space, time and energy are limited, use them wisely. Answer the questions in the spaces provided. **Use of additional supplements/ rough pages is prohibited**. Students may carry one book along with their own hand written notes during the examination. Notes should be properly clipped together with student ID written on each page. Notes with loose pages are not permitted. Use of scientific calculator is permitted during the examination. It is mandatory to fill up the expected points for attempted questions in the assessment table, the questions for which the entries are missing will not be evaluated.

(Student Name) (Student ID) (Sign of Invigilator)

Question:	1	2	3	4	Total
Points:	10	10	20	20	60
Your Expectation:					
Score:					

Question 1

(a) Propose an admissible heuristic for the graph in Figure 1. The resolution of the regular planar grid is 10 km per unit in horizontal as well as vertical directions. Is the proposed heuristic consistent? (5)

(b) Check if starting from source node S following A^* with your proposed heuristic the path identified to reach the goal node G is optimal or not. (5)

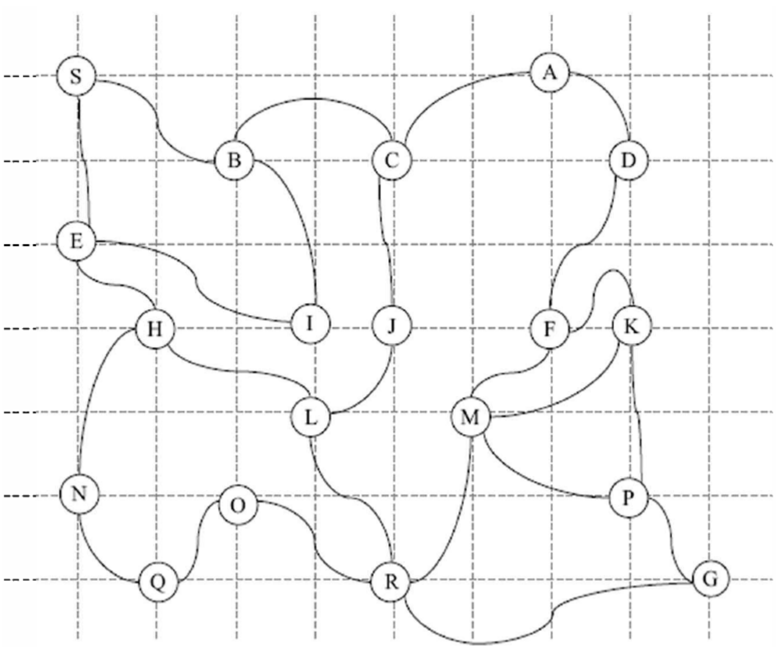

Figure 1: A Graph

Score:

Question 2

Consider a game tree shown in Figure 2. The rectangle nodes are max nodes and circles are min nodes.

(a) What is the best that max node (root) can achieve? Use MINIMAX algorithm. (2)

(b) Perform alpha-beta pruning (performing search from left to right), and indicate the amount of saving. (4)

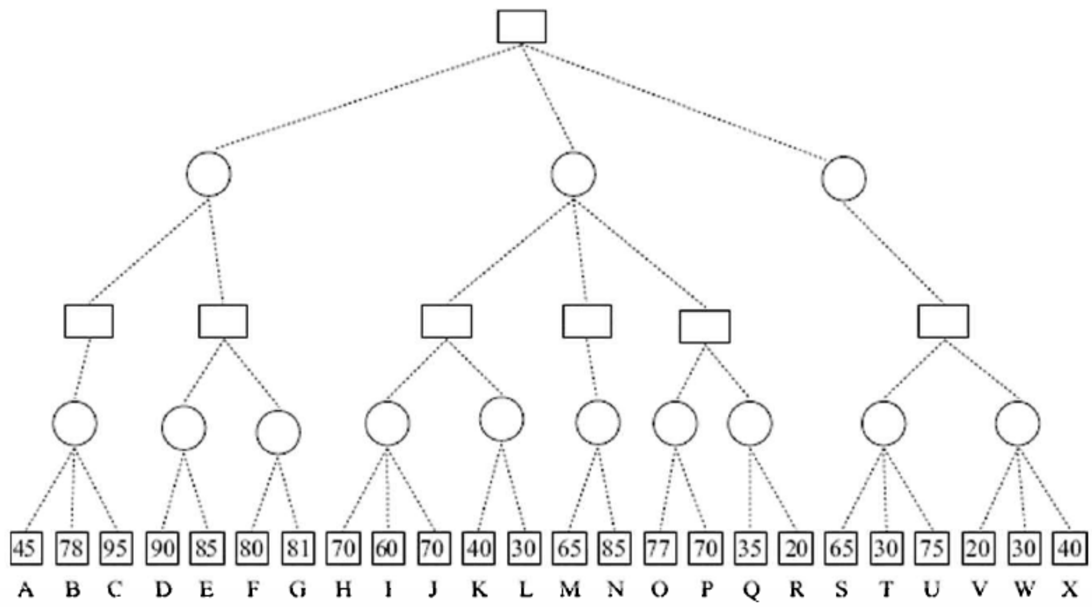

Figure 2: Small Game Tree

(c) Perform alpha-beta pruning, from right to left, and indicate the amount of saving. (4)

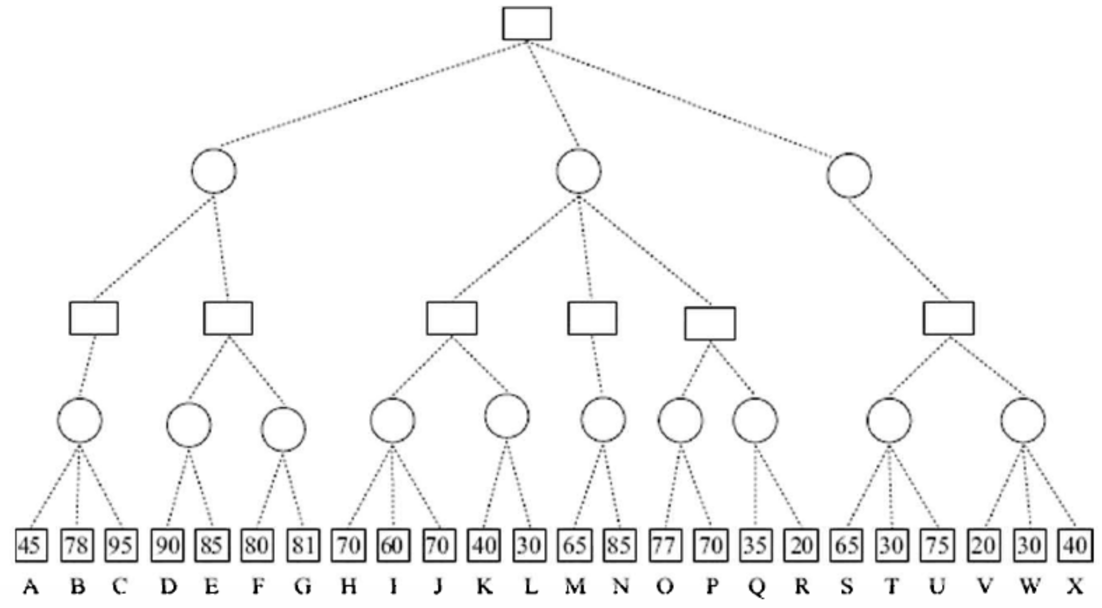

Figure 3: Small Game Tree

 Score:

Question 3

Consider an LED display with 7 elements numbered as shown in Figure 4. The state of the display is a vector x. When the controller wants the display to show character number s, e.g. $s = 2$, each element x_j $(j = 1, \ldots, 7)$ either adopts its intended state $c_j(s)$, with probability $1 - f$, or is flipped, with probability f. The states of x can either be $+1$ or -1.

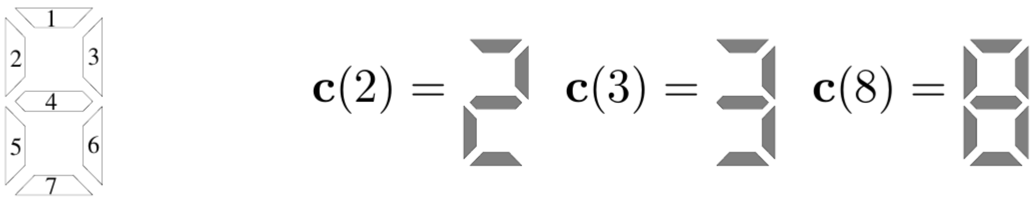

Figure 4: LED display with 7 elements

(a) Assuming that the intended character is actually a 2 or a 3, what is the probability of s, given the state x? Show that $P(s = 2|x)$ can be written in the form (5)

$$P(s = 2|x) = \frac{1}{1 + exp(-w^T x + \theta)}$$

and compute the value of the weights w in the case $f = 0.2$.

(b) The 7 element LED panel is configured as an auto-associative network for error correction. Given that only two characters, i.e. 2 and 3, are to be stored in the network what should be the corresponding W according to Hebbian learning rule? (5)

(c) Check if $s = 2$ and $s = 3$ are the fixed points of the dynamical system $c^{t+1} = sgn(Wc^t)$, where $c^t \in \{-1, +1\}^7$ or not. (5)

(d) Using pseudo inverse find the optimal matrix W which stores $s = 2$ and $s = 3$. (5)

Question 4

For the noisy LED display shown in Figure 4, the following states were observed for $s = 2$ and $s = 3$. You may consider s as the class variable.

Table 1: Some observations on 7 element LED states and corresponding numbers

(a) Observations on noisy LED

ID	x_1	x_2	x_3	x_4	x_5	x_6	x_7	s
1	1	-1	1	1	1	-1	1	2
2	1	-1	1	1	1	-1	1	2
3	1	-1	1	1	1	-1	1	2
4	1	-1	1	-1	1	-1	1	2
5	1	-1	-1	1	1	-1	1	2
6	1	-1	1	1	1	-1	-1	2
7	1	-1	1	1	-1	1	1	3
8	1	-1	1	1	-1	1	1	3
9	1	-1	1	1	-1	1	1	3
10	1	-1	1	1	-1	-1	1	3
11	-1	-1	1	1	-1	1	1	3
12	1	-1	1	1	-1	1	-1	3

(b) Additional observations on noisy LED

ID	x_1	x_2	x_3	x_4	x_5	x_6	x_7	s
13	1	-1	1	1	1	-1	1	2
14	1	-1	1	-1	1	-1	1	2
15	1	-1	-1	1	1	-1	1	2
16	1	-1	1	1	1	-1	-1	2
17	1	-1	1	1	-1	1	1	2
18	1	-1	1	1	-1	1	1	3
19	1	-1	1	1	-1	-1	1	3
20	-1	-1	1	1	-1	1	1	3
21	1	-1	1	1	-1	1	-1	3
22	1	-1	1	1	1	-1	1	3

 Score:

(a) Use directed graphical model of your choice to learn the joint probability $P(x, s)$ from the observation Table 1a. Describe how would you answer the following classification query $P(s|x)$. (5)

(b) Use undirected graphical model of your choice to learn the joint probability from the observation Table 1a. Describe how would you answer the following classification query $P(s|x)$. (5)

 Score:

(c) Build a decision tree classifier (using information gain) for the observations of Table 1a. Accordingly, explain how it will arrive at the class label for $x = [1, -1, -1, -1, 1, -1, 1]$. (5)

(d) Suppose a few additional observations as mentioned in Table 1b are made available. Explain how will these additional observations affect each of the above trained classifiers. (5)

 Score: