Roll Number: _____ **Name:** _____

Thapar Institute of Engineering & Technology, Patiala
(Deemed to be University)
Department of Electronics & Communication Engineering
End-semester examination

Date: December 06, 2022	**Programme: ENC, ECE**
Course code: UCS411	**Course name: Artificial Intelligence**
Time: 03 hours, Max. marks: 40	**Name of Faculty: VK, RU, NS, SM**

NOTE: * Attempt all questions and mark your answers in the table only.
**** Assume any missing information.**

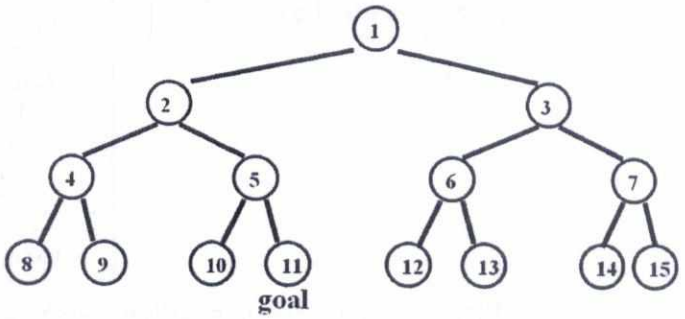
Q1. Search plays an important role in Artificial Intelligence. The complexity of the search algorithms leaves a mark on the AI systems' performance. Breadth-First Search (BFS) and Depth-First Search (DFS) have limitations, depth-first iterative-deepening search (DFIDS) algorithms are used to overcome these limitations. **[10 marks]**

You have to answer the following:

I. State the limitations of BFS and DFS. For the graph given below suppose the goal state is 11. List the order in which nodes will be visited for BFS and DFS.

II. State the advantages of DFIDS.

III. For the graph given below suppose the goal state is 11. List the order in which nodes will be visited for DFIDS in various iterations (For this part of the question, your answer must be in the following format:
Iteration 1: write the visited nodes
Iteration 2: write the visited nodes
.....)

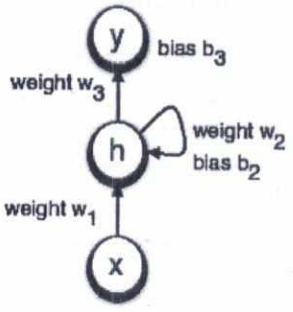


Q2. (a) Recall that a recurrent neural network (RNN) takes in an input vector x_t and a state vector h_{t-1} and returns a new state vector h_t and an output vector y_t :

$$h_t = f(w_1 x_t + w_2 h_{t-1} + b_2)$$
$$y_t = g(w_3 h_t + b_3)$$

where f and g are activations, defined as:

$$f(x) = \begin{cases} 0, x < 0 \\ 1, x \geq 0 \end{cases}$$
$$g(x) = x$$



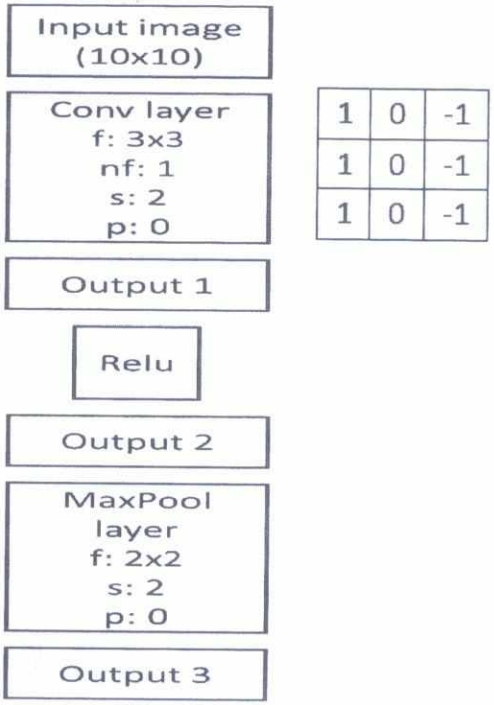
Provide one possible solution for weights (w1, w2, w3) and biases (b2, b3) so that the RNN initially outputs 0, but as soon as it receives an input of 1, it switches to output 1 for all subsequent time steps. For instance, the input 00101 produces the output 00111. The hidden unit has an initial value of $h_0 = 1$. **[5 Marks]**

Q2. (b) Explain the working of LSTM network using suitable diagram. **[5 Marks]**

Q3. How do we apply backpropagation in a Neural Network, give the mathematical details for a multilayer perceptron model using Sigmoid function? **[10 marks]**

Q4. (a) An input image (2d array) is shown in Fig. 1(a). This input is fed to a CNN network shown in Fig. 1(b). Find the output array and its dimension for each layer. The 3x3 filter for Conv layer is shown in Fig. 1(c) (ignore bias for calculations) **(f: filter size, nf: number of filters, s: stride, p: padding)** **[5 marks]**

1	2	31	2	9	7	34	22	11	5
11	92	4	3	2	2	3	3	2	1
3	9	13	8	21	17	4	2	1	4
8	32	1	2	34	18	7	78	10	7
9	22	3	9	8	71	12	22	17	3
13	21	21	9	2	47	1	81	21	9
21	12	53	12	91	24	81	8	91	2
61	8	33	82	19	87	16	3	1	55
54	4	78	24	18	11	4	2	99	5
13	22	32	42	9	15	9	22	1	21



1	0	-1
1	0	-1
1	0	-1

Figure 1 (a) input image (left), (b) CNN network (middle), and (c) filter (right).

Q4. (b) For the given CNN network specification in Table below, calculate and fill the number of learnable parameters in last column. Input data shape for this network is 32x32x3. (ignore bias for calculations) **[5 marks]**

CNN layers	Layer specification	Number of learnable parameters
Conv 1	nf: 6, f: 3x3, p: 0, s: 1	
Max pooling	f: 2x2, p: 0, s: 2	
Conv 2	nf: 16, f: 5x5, p: 0, s: 2	
Max pooling	f: 2x2, p: 0, s: 2	
Flatten	--	
Dense (fully connected) 1	neuron units:120	
Dense (fully connected) 2	neuron units: 84	
Dense (fully connected) 3	neuron units: 10	
		Total:

END