Birla Institute of Technology & Science, Pilani
Work Integrated Learning Programmes Division
Second Semester 2018-19
M.Tech. (Data Science and Engineering)
Comprehensive Examination

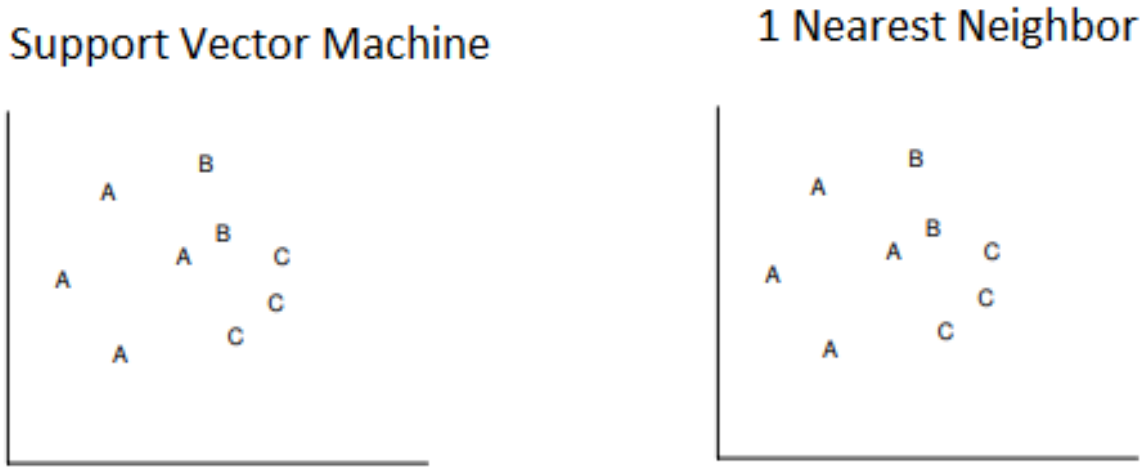
Course No.	: DSECL ZG565
Course Title	: MACHINE LEARNING
Nature of Exam	: Open Book
Weightage	: 40%
Duration	: 2 Hours 30 Minutes
Date of Exam:	November 10, 2019

No. of Pages = 3
No. of Questions = 6

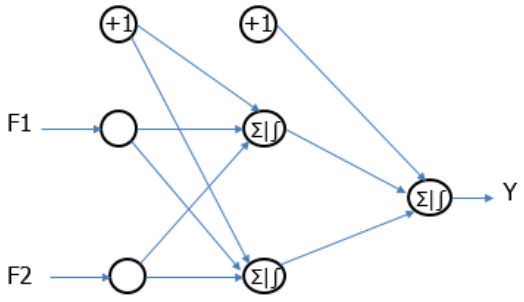
Time of Exam: 10:00 AM – 12:30 PM

Note:
1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.

Question 1. Draw the decision boundary generated by SVM and 1 nearest neighbour classifiers. [2+2=4] **[to be answered on page 3-4]**



Question 2. Consider the neural network model with exp( ) activation function to classify the training data given in the adjoining table. [6+1.5 = 7.5] **[to be answered on page 5-7]**



F1	F2	Y
1	2	0
1	1	+1
2	1	0
2	2	+1

(a) Obtain the node weights
(b) Bias weights to classify the training data correctly

Question 3. Answer the following questions. [3+3+2=8] **[to be answered on page 8-10]**

Feature probability distribution of two classes of data points are given by

$$P\,(x, y\,|class_0) = \frac{1}{2\pi\sigma_x\sigma_y}\exp\frac{-(x-1)^2}{2\sigma_x^2} - \frac{y^2}{2\sigma_y^2}$$

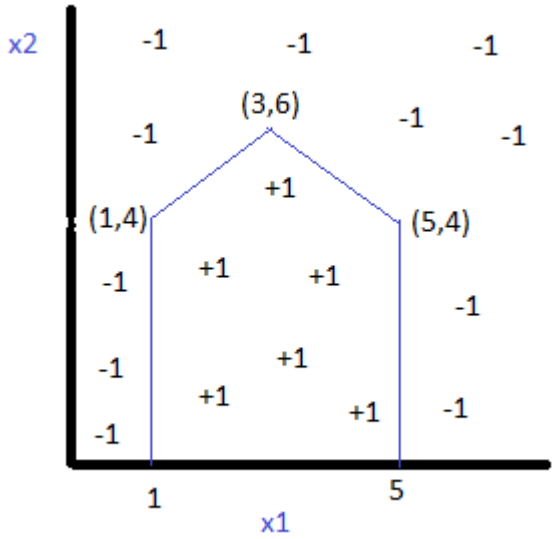
and

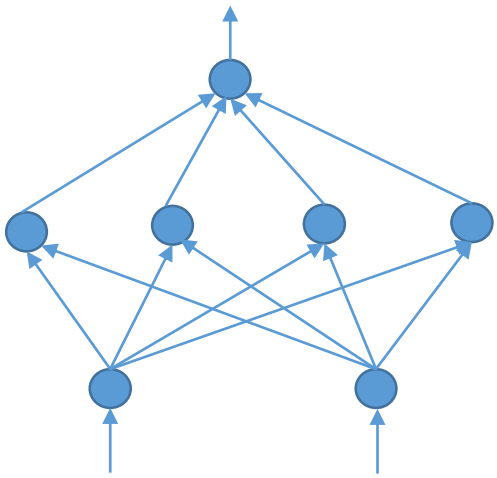
$$P\,(x, y\,|class_1) = \frac{1}{2\pi\sigma_x\sigma_y}\exp\frac{-x^2}{2\sigma_y^2} - \frac{(y-2)^2}{2\sigma_x^2}$$

Both classes are equally likely.

a) Derive the equation of decision boundary.
b) What is the equation and shape of the boundary if $\sigma_x = \sigma_y = \sigma$? Draw the distributions and mark decision boundary.
c) What is the shape of the boundary if $\sigma_x \neq \sigma_y$? Draw the distributions and mark decision boundary.

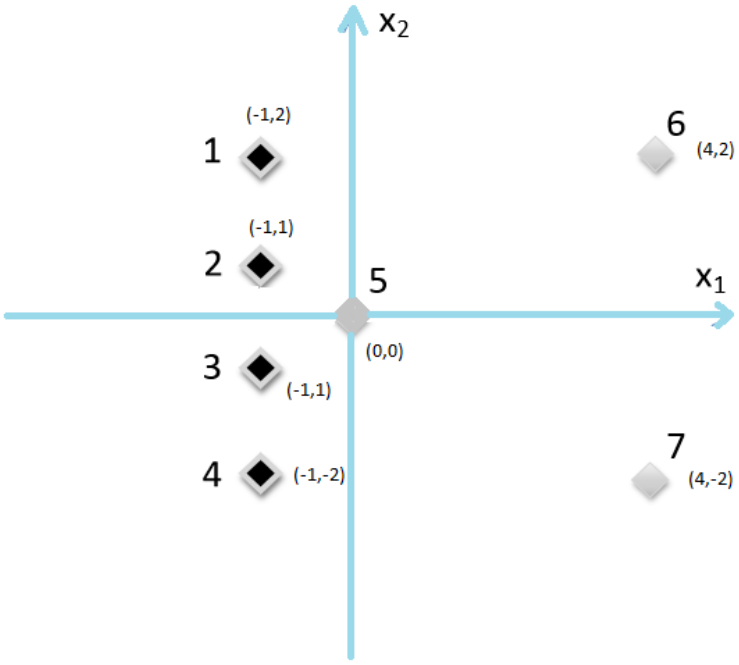
Question 4. The decision boundary for a two-class +1/-1 problem is given below in left. Specify the parameters weights and bias of the perception network on the right that can generate the given decision boundary. Note for a perceptron node, the output is +1 for input greater than or equal to 0, else output is -1. [6 + 2 = 8] **[to be answered on page 11-13]**





Question 5. Consider a 2-class classification problem in a 2 dimensional feature space **x**=[x1, x2] with target variable y=±1.The training data comprises 7 samples as shown in Figure on next page. 4 black diamonds denote the positive class and 3 gray diamonds for the negative class. [2+1+1+2.5 = 6.5] **[to be answered on page 14-16]**

a) What is the equation of the decision boundary if SVM is used?
b) What is the training error rate?
c) The removal of which sample will change the decision boundary?
d) What is the leave-one-out cross validation error rate?



Note: Leave-one-out cross validation is performed by training a classifier with (n-1) training samples and testing on the remaining one sample. This process is repeated for every sample in the training set. Error rate is the ratio of number of wrongly classified samples and total number of samples.

Question 6. Design a maximum margin SVM classifier for the following dataset. Draw the decision boundary along with the data points in (F1, F2) space. [5+1=6] **[to be answered on page 17-19]**

F1	F2	Class
0	1	0
2	1	0
2	2	1
0	2	0
-2	1	0
-2	2	1
-2	0	1
0	0	0
2	0	1