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

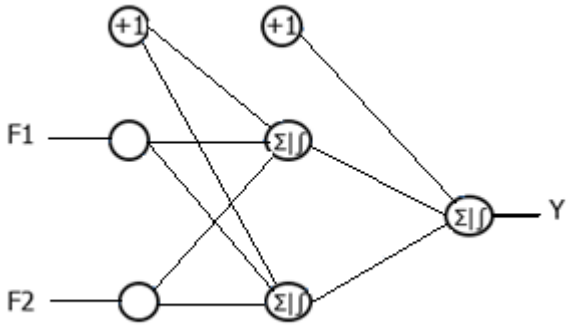
Course No.	: DSECL ZG565
Course Title	: MACHINE LEARNING
Nature of Exam	: Open Book
Weightage	: 40%
Duration	: 2 Hours 30 Minutes
Date of Exam:	November 17, 2019

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. Consider the neural network model with *tanh*() activation function to classify the training data given in the adjoining table. [6 + 1.5 = 7.5] **[to be answered on page 3-5]**



Feature F1	Feature F2	Class Y
1	2	+1
1	1	-1
2	1	+1
2	2	-1

a) Obtain the node weights, and
b) bias weights to classify the training patterns correctly.

Question 2. Find the equation for maximum margin hyper plane using linear Support Vector Machine method for the training samples given below. Draw the decision boundary along with data points. [3+1=4] **[to be answered on page 6-8]**

Feature F1	Feature F2	Class
3	2	Bus
4	3	Bus
1	0	Car
1	-1	Car
0	2	Car
3	-1	Bus
-1	2	Car

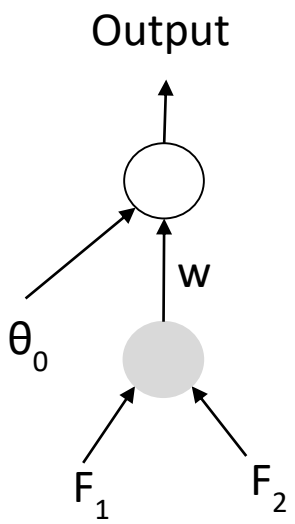
Question 3. Find the equation for maximum margin hyper plane in feature space using nonlinear SVM. Positive Points in feature space: {(1,2), (2,1), (3,2), (2,3)} Negative Points in feature space: {(2,5), (5,2), (2,-1), (-1,2)}, Draw the decision boundary along with data points. [7+1=8]
[to be answered on page 9-11]

Question 4. The following table shows attribute values of 3 samples belonging to Class 0 and Class 1, respectively. Prior probability of Class 0 and Class 1 are, respectively, 0.7 and 0.3. Answer the following. [2+1+1+1=5] **[to be answered on page 12-14]**

Class 0	15	25	35
Class 1	45	65	55

a. Calculate the mean and variance of attribute value w.r.t. Class 0 and Class 1.
b. Assuming Gaussian distribution for both classes, which class does the test sample with attribute value 40 belong to?
c. If the attribute value of test sample is 75, which class does the sample belong to?
d. If the feature value is 10, which class does the sample belong to?

Question 5. The Radial Basis Function network on the left below is used to classify the data points given in the right below. [3+2+2=7] **[to be answered on page 15-17]**



F1	F2	Output
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

The radial function in the hidden layer is specified as

$$g(F_1, F_2) = \frac{1}{2\,\pi} \exp^{-\frac{F_1^2}{2} - \frac{(F_2-1)^2}{2}}$$

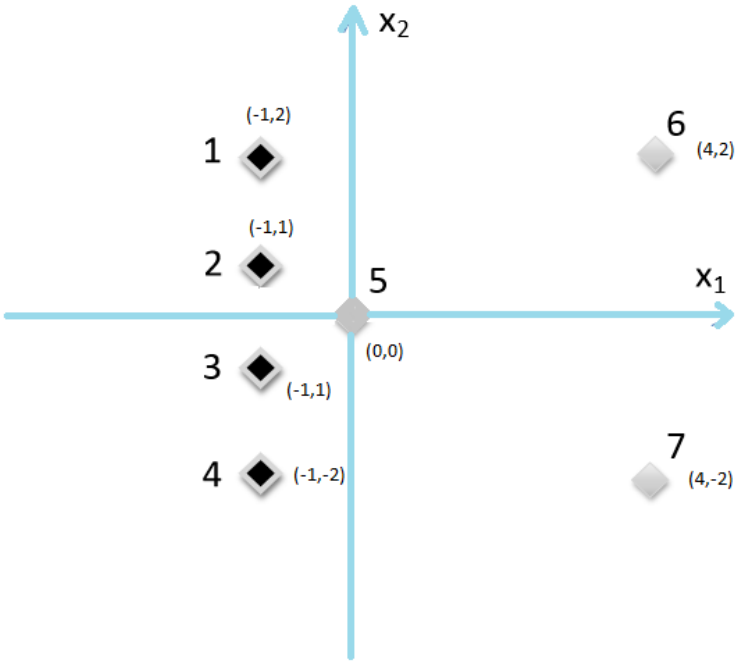
and Output is +1 when input >= θ_0, else output is 0.

a) Calculate the outputs of hidden node for the training data points.
b) Specify the weight w and
c) bias θ_0 to classify the training data correctly.

Question 6. 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 for the positive class and 3 gray diamonds for the negative class. [2+2+1+1+2.5= 8.5]
[to be answered on page 18-20]

a) Find the k-means cluster centers for the two (black diamond and gray diamonds) classes.
b) What is the equation for linear decision boundary which is equidistant from the two cluster center?
c) What is the training error rate?

d) Is there any sample such that upon its removal, the decision boundary changes in a manner that the removed sample goes to the other side?
e) 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.