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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

V Semester B. E. Examinations Jan/Feb-21

Electronics and Communication Engineering

DIGITAL SIGNAL PROCESSING AND MACHINE LEARNING

Time: 03 Hours *Maximum Marks: 100*

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6
3. Use of Butterworth and Chebyshev tables is permitted

PART-A

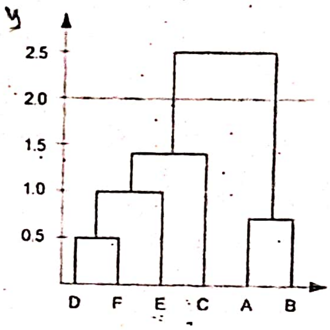
1	1.1	Find the cutoff frequency (rad/sec) of third order low pass Butterworth filter with 11.21 dB stop band attenuation at stop band frequency of 2.198 rad/sec. 1.44.	01
	1.2	For the given difference equation, find the required number of Delay elements for the realization of Direct form-1 and Direct-form-2 structure. 5, 3. $2 * Y[n] - 2 * y[n-1] + 3 * y[n-2] = x[n] + 2x[n-3]$	01
	1.3	The Hamming window coefficient $w(4)$ of Type 1 (Symmetric Odd) FIR filter whose slope is 3 is given by ______. .77, .08	01
	1.4	The frequency response of an FIR filter is given by $H(w) = e^{-j3\omega}(1 + 1.8 * Cos3\omega + 1.2 * Cos2\omega + 0.5 * Cos\omega)$ Determine the coefficient $h(0)$ of the impulse response of the FIR filter. 0.9	01
	1.5	If in the below logistic function, b_0 is -9.346 and b_1 is 0.014634 the predicted value for X_1 = 721 would by ______ $\widehat{\pi_i} = \frac{e^{b_0+b_1X_1}}{1+e^{b_0+b_1X_1}}$	01
	1.6	The estimate of the Poisson model (data table as given below) using the following equation is ______, with n = 647. $\widehat{\lambda_{ML}} = \bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$	01
	1.7	The classifier that contains hyperplane with a ______ margin is more susceptible to over fitting model and tend to classify with weak confidence on unseen data.	01
	1.8	In support vector machine, a decision boundary is ______ to hyperplane and touches the ______ class in one side of the hyperplane.	01

Number of accidents	0	1	2	3	4	5
Frequency	447	132	42	21	3	2

0000565 7

Welcome@123

23.01

1.9	Suppose, x1 and x2 are two points on the decision boundaries b1 and b2, respectively and represented in matrix form as $W.X1 + b = 1$ and $W.X2 + b = -1$. Then the margin of the hyperplane is given by_______	01
1.10	The number of segments formed at y=2 in fig.1.10 below. Use k-means clustering.  Fig. 1.10	01
1.11	The frequency response of a digital FIR filter is given as $H(\omega) = [0.4 + 0.7cos2\omega - 0.5cos4\omega]e^{-j(0.3\pi+4\omega)}$ The group delay and phase delay are ___4___ and ___$4 + \frac{.3\pi}{\omega}$___	02
1.12	The Butterworth LPF has to meet following specification: Passband frequency: 4rad/sec, Passband gain = -1dB Stopband frequency: 8 rad/sec, Stopband attenuation = 20dB Find the order of the Butterworth filter? N=5	02
1.13	It is necessary to cluster the given seven observations into three clusters using K-means clustering. After 1st iteration, the three clusters have the following observations: Cluster_1: {(2,2), (4,4), (6,6)} Cluster_2: {(0,4), (4,0)} Cluster_3: {(5,5), (9,9)}. Find the cluster centroids to proceed to 2nd iteration.	02
—1.14	If n=300, SSE is 100 and Total sum of squares is 400, what is the value of R^2?	02
—1.15	Residual SD = 0.18055, slope b of Linear regression fit is 1.033, with t = 2.160 for degrees of freedom of 13, the 95% confidence interval is from _____to _________	02

PART-B

2	a S true – 2M – 6 M b .2566 2	The normalized transfer function of an analog filter is given by, $H(s) = \dfrac{1}{S^2 + 1.141S + 1}$ Convert the analog filter to a digital filter with a cutoff frequency of 0.4π rad/sec, using bilinear transformation. A digital IIR low pass filter is required to meet the following specifications Ripples in pass-band and monotonic in stop-band. $\Omega p = 1.14$ 1dB attenuation at frequency of 0.33π rad. $\Omega s = 3.38$ } – 2 Stop-band attenuation of at lead 40 dB at 0.66π rad. N = 4 — 2M Find the system function $H(z)$ by performing a bilinear transformation on an analog system function. (use tables)	08 08

$d = 5.09 \times 10^{-3}$
$k = .3375$

$H(S) = \dfrac{.246}{S^4}$ γ

KN = .245

H(z) → 2M

$h(0) = .1009$ $h(3) = .2$
$h(1)$
$h(2) = .1514$
$h(2) = .1841$

3 a Design a linear phase FIR lowpass filter using rectangular window by taking 7 samples of window sequence and with cutoff frequency, $\omega_c = 0.2\pi\ rad/sample$ — 10

$SM \rightarrow .2 + .2\cos 3\omega + .3\cos 2\omega + .37\cos\omega$

b Derive the expression for the frequency response of a linear phase FIR filter if the order is even and impulse response is symmetrical. — 06

$H(\omega) - SM$

OR

4 a Determine the filter coefficients $h(n)$ obtained by frequency sampling

$h(n) = 4M$ $h(0) = h(6) = -.11$ $h(1) = h(5) = .07$

$$H_d(e^{j\omega}) = \begin{cases} e^{-j(N-1)\omega/2} & 0 \le |\omega| \le \pi/2 \\ 0 & \pi/2 \le |\omega| \le \pi \end{cases}$$

$H(\omega) = 2M$

For N = 7 $h(2) = h(4) = .321$ $h(3) = .428$ $2M - H(k) = e^{-6\pi k/7}$ $\rightarrow k = 0, 1$ $\rightarrow k = 2, 3, 4, 5$

0 $e^{-6\pi(k-7)/7}$ $\rightarrow k = 6$

Draw the magnitude and phase response. — 10

b Derive the expression for the frequency response of a linear phase FIR filter if the order is odd and impulse response is symmetrical. — 06

5 a In least square regressions problem, derive an expression for slope 'm' and y intercept 'c' to minimize the squared error. Given the individual errors are

$Error1 = y1 - (mx1 + c)$

$Error2 = y2 - (mx2 + c)$

....

$Error = yn - (mxn + c)$ — 06

b Calculate the regression coefficient and obtain the lines of regression for the following data — 10

X	1	2	3	4	5	6	7
Y	9	8	10	12	11	13	14

OR

6 a Define loss function and minimization of loss function using stochastic gradient decent optimization method. — 06

b We observe the independent variables x_1 and x_2 and the dependent variable (or response variable) y along with it and is given by.

	x1	x2	Y
1)	4	1	2
2)	2	8	-14
3)	1	0	1
4)	3	2	-1
5)	1	4	-7
6)	6	7	-8

Implement the Gradient decent algorithm to find the weights w1, w2 and the bias b to minimize the error only for $epoch = 1/1$, Batch = 1/6. Initialize the weights $w1 = -0.017, w2 = -0.048$ and b=0, batch size = 1, learning rate = 0.5, $epoch = 1/1$, Batch = 1/6 — 10

7 a Define Baye's Theorem, If E1, E2, E3..., En are a set of n mutually exclusive and collectively exhaustive events. — 06

	b	From the data set given below, using Naïve Bayes Algorithm, Find the probability of playing when the weather is overcast	10
8	a	Explain the steps involved in unsupervised k-means clustering techniques in partitions the given data set into k predefined distinct clusters. Mention its advantages and disadvantages.	06
	b	Using the algorithm steps explained in question 8(a), Separate the given data into 2 clusters.	10

Whether	Play
Sunny	No
Sunny	No
Overcast	Yes
Rainy	Yes
Rainy	Yes
Rainy	No
Overcast	Yes
Sunny	No
Sunny	Yes
Rainy	Yes
Sunny	Yes
Overcast	Yes
Overcast	Yes
Rainy	No

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width
1	5.1	3.5	1.4	0.2
2	4.9	3	1.4	0.2
3	7	3.2	4.7	1.4
4	6.4	3.2	4.5	1.5
5	6.3	3.3	6	2.5
6	5.8	2.7	5.1	1.9

Assume the following

a) Consider initial cluster centers as 3rd and 6th observation.
b) Use Rectilinear Distance measurement.
c) Use Single linkage while finding the cluster.
d) Repeat the procedure until there is no change in clustering from one iteration to next iteration.
e) Draw the pictorial representation of clustering of each iteration on X, Y pane.