2024

COMPUTER SCIENCE

Paper : CSMC-301

(Image Processing and Pattern Recognition)

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question nos.*** **1 & 2,** and ***any four*** questions from the rest.

1. Answer ***any five*** questions from the following : 2×5

(a) What is the impact of image multiplication in a region of interest?

(b) How are smoothing filters used for blurring and noise reduction?

(c) The second derivative enhances fine detail much better than the first derivative. Critically comment.

(d) What is intensity resolution? How can you measure it?

(e) How does the Weber Ratio affect the brightness of an image?

(f) Perform shear (vertical) transformation on the following matrix :

1	3	1	3
2	4	6	1
2	6	5	3
5	3	4	2

(g) How does correlation differ from convolution? Show an example.

2. Answer ***any five*** questions from the following : 4×5

(a) Differentiate between contrast enhancement and spatial enhancement.

(b) 'Bicubic interpolation yields sharper results than bilinear interpolation'— Justify.

(c) What is a payoff matrix? What is the implication in classification?

(d) What is gamma correction? Mention its applications.

(e) How can you select the suitable size and pixel depth of images?

(f) How does correlation differ from convolution? Show with an example.

(g) What is the motivation for sharpening filters? Critically comment on the following statement : "The second derivative enhances fine detail much better than the first derivative."

3. (a) What are the different types of noises that may appear in an image? Explain them in brief with diagrams.

(b) How can median filters be used to reduce the noise of an image? 6+4

4. (a) 'Histogram matching' is a useful contrast manipulation technique that transforms an image's histogram to match another image. Describe how you can achieve it.

(b) Consider a 3-bit image (L = 8) of size 64 * 64 pixels (MN = 4096) has the intensity distribution shown in the following table : 5+5

r_k	n_k
$r_0 = 0$	780
$r_1 = 1$	1123
$r_2 = 2$	81
$r_3 = 3$	636
$r_4 = 4$	349
$r_5 = 5$	244
$r_6 = 6$	123
$r_7 = 7$	760

Perform histogram equalization of this image.

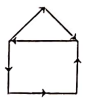
5. (a) Convert the following 3-bit RGB image to the CMY model :

1,2,5	4,1,5	5,4,2	2,1,4
3,6,5	4,1,3	6,6,1	5,4,1
2,1,4	3,1,4	4,2,3	1,4,3
3,2,1	3,1,3	1,1,2	2,3,1

(b) Describe in brief the filters that can remove different types of noises by changing the value of the order of the filter. 6+4

6. (a) Write down the steps of the K-means algorithm to find out the clusters. Mention the factors by which the behaviour of the K-means algorithm is influenced.

(b) Write down the Picture Definition Language (PDL) grammar, which can generate the following diagram : (4+2)+4



7. (a) Write briefly about the traditional Canny edge detection technique. What are the main defects of this algorithm? Explain.

(b) Find out the Huffman encoding and the code length of a message containing the following characters and frequency. Show the steps of source reduction and draw the Huffman tree. (3+3)+4

Character	Frequency
a	2
b	8
c	9
d	17
e	25
f	50

2024

ELECTRONIC SCIENCE

Paper : ITGE-31

(Digital Signal Processing)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Symbols have their usual significances.

Answer ***any five*** questions.

Instructions :

- Attempt **any 5 questions** out of the 7 provided.
- Each question carries **10 marks.**
- Write all assumptions and steps clearly.

1. (a) Define the unit step, delta, ramp, sine, and cosine sequences with suitable mathematical expressions and sketches.

   (b) Consider the sequence x[n] = 2u[n] – u[n – 4]. Find and plot x[n].

2. (a) Explain how any arbitrary time sequence can be represented using the delta sequence. Provide an example.

   (b) Represent the sequence x[n]={3, 1, –1, 2} using the delta sequence.

3. (a) Derive the output of an LTI system given input x[n] and impulse response h[n] using the convolution sum.

   (b) Given x[n] = {1, 2, 3} and h[n]={1, –1}, compute y[n] = x[n]*h[n] (convolution).

4. (a) State and prove the periodicity and linearity properties of the DFT.

   (b) Compute the 4-point DFT of the sequence x[n]={1, 0, 1, 0}.

5. (a) Find the Z-transform and ROC of the sequence x[n] = a^n u[n], where |a|<1.

   (b) Discuss the significance of ROC in determining the stability and causality of a system.

6. (a) Explain the design principles of high-pass and low-pass digital filters.

   (b) Derive the transfer function of a simple low-pass digital filter and sketch its magnitude response.

7. (a) Explain the process of convolution using the Discrete Fourier Transform (DFT).

   (b) Compute the linear convolution of x[n]={1, 2} and h[n]={1, 1} using DFT and inverse DFT.

2024

ELECTRONIC SCIENCE

Paper : ELC-GE-31

(Electronics)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Symbols have their usual significances.

Answer ***any five*** questions.

1. (a) Deduce the expression for contact potential in a *p-n* junction.

   (b) A Si abrupt *p-n* junction has $N_a = 10^{18}\text{cm}^{-3}$ on one side and $N_d = 5 \times 10^{15}\ \text{cm}^{-3}$ on the other side : (i) calculate the Fermi level positions at 300 K in the *p*- and *n*-regions. Hence find the contact potential; and (ii) draw an equilibrium band diagram for the junction and determine the contact potential V_0 from the diagram. 4+(4+2)

2. (a) Explain with a labeled diagram the different current components in a transistor.

   (b) Define α and β and find the relationship between them.

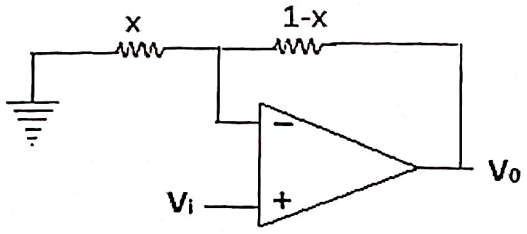
   (c) Explain early effect in transistor and explain how it affects the input and output characteristics of the transistor. 3+4+3

3. (a) Why is the hybrid model only valid for small signals?

   (b) Find the expressions for : (i) input impedance, (ii) current gain, (iii) voltage gain and (iv) output impedance without taking the source resistance into account. 2+8

4. (a) What is the need for level shifter in an OPAMP?

   (b) Show that the gain of the given amplifier is $A_v = 1/X$ with response to the given circuit.



   (c) Derive the expression for voltage gain of a differential amplifier using OPAMP. 2+4+4

Please Turn Over

5. (a) Draw a schematic diagram for n-channel JFET and MOSFET.

(b) Explain pinch off effect for JFET and explain its behaviour after pinch off.

(c) Draw the output drain characteristics for a n-channel JFET and mention each region in the characteristics curve.

(d) What is the significance of threshold voltage for EMOSFET and DMOSFET? (1+1)+(2+2)+(1+1)+(1+1)

6. (a) Write down the equation for gain with feedback and hence explain the following conditions :

(i) If $1+A\beta<1$

(ii) If $1+A\beta>1$

(iii) If $1+A\beta=0$

(iv) If $1+A\beta>>1$,

where symbols have their usual meaning.

(b) Compare voltage series and current series feedback.

(c) Mentioning the condition for frequency of oscillation, briefly explain phase shift oscillator. (1+1+1+1+1)+2+3

7. (a) Using IC74153 make an equivalent 8 : 1 MUX.

(b) Why MUX is also known as basic building block for digital circuits? Explain with examples.

(c) Briefly describe the working principle of a 3-bit even parity checker. 2+(1+2)+5

8. (a) Compare between combinational and sequential logic circuits.

(b) What are the disadvantages of S-R FF and what is its remedy?

(c) Draw a neat diagram for MOD-10 asynchronous counter.

(d) Draw the timing diagram of a Serial-In-Serial-Out (SISO) shift register where a steady logical-1 is applied at the serial input line connected to 1st stage of the SISO shift register (Draw up-to 4 clock pulses). 2+(2+2)+2+2

2024

COMPUTER SCIENCE

Paper : CSMC-304

(Artificial Intelligence)

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question nos.*** **1, 2** and ***any four*** questions from the rest.

1. Answer ***any five*** questions : 2×5

(a) State the differences between Depth First Search and Breadth-First Search.

(b) Compute the number of learnable parameters for 5-3-2-3-3 multilayer perceptron.

(c) 'ID3 uses base 2 in log operatio.'— Justify.

(d) How can one decide the value of 'k' in the k-means algorithm?

(e) State the differences between supervised learning and unsupervised learning.

(f) State modus ponen with the help of an example.

(g) Prove that the statement $((\sim P + Q) \equiv (P \rightarrow Q))$ is invalid.

2. Answer ***any five*** questions :

(a) Let A = {mimi, bob, kitty, jina} be a set of four children, and B={tintin, asterix, phantom, mickey} be a set of four comic characters; and C = {funny, cute, dreamy} be a set of three nature attributes. The fuzzy relations R=x likes y is defined on $A \times B$, and $S = x$ IS y is defined on $B \times C$, as shown in Table 1A and Table 1B. Find out the fuzzy relation $T = x$ IS y defined on $A \times C$.

Table : 1A :— R= x likes y on A×B

	Tintin	Asterix	Phantom	Mickey
mimi	0.8	0.5	0.7	0.8
bob	0.4	0.9	0.3	0.3
kitty	0.6	0.7	0.4	0.9
jina	0.3	0.8	0.2	0.5

Table : 1B :--$S = x$ IS y on B×C

	funny	cute	dreamy
tintin	0.6	0.7	0.3
asterix	0.8	0.4	0.2
phantom	0.1	0.2	0.1
mickey	0.9	0.8	0.3

(b) State the working principle of different types of agents in Artificial intelligence. 4

(c) Consider the following problem : A Water Jug Problem : You are given two jugs, a 4-gallon one and a 3-gallon one, a pump that has unlimited water, which you can use to fill the jug, and the ground on which water may be poured. Neither jug has any measuring markings on it. How can you get exactly 2 gallons of water in the 4-gallon jug? Generate the rules and apply them. 4

(d) Prove that

$Err_j = O_j\,(1-O_j)(T_j - O_j)$

where T_j = true output of the neural network (j^{th} neuron)

O_j = Obtained Output of the neural network (j^{th} neuron)

Err_j = Error at j^{th} Neuron

The network is trained through backpropagation learning. 4

(e) State MADALINE MR-I algorithm for 4-2-1 topology. 4

(f) State fuzzy c-means with proper mathematical notations. 4

(g) (i) State the differences between the Uniform-cost Search Algorithm and Iterative deepening depth-first Search.

(ii) Explain the Expert System development environment with the help of a block diagram. 1+3

3. (a) Draw the decision tree using the CART algorithm upto two levels. Please refer to Table 2.

Table - 2

Day	Outlook	Temperature	Humidity	Wind	Decision: (Golf Play possible)
1	Sunny	Hot	High	Weak	No
2	Sunny	Hot	High	Strong	No
3	Overcast	Hot	High	Weak	Yes
4	Rain	Mild	High	Weak	Yes
5	Rain	Cool	Normal	Weak	Yes
6	Rain	Cool	Normal	Strong	No
7	Overcast	Cool	Normal	Strong	Yes
8	Sunny	Mild	High	Weak	No
9	Sunny	Cool	Normal	Weak	Yes
10	Rain	Mild	Normal	Weak	Yes
11	Sunny	Mild	Normal	Strong	Yes
12	Overcast	Mild	High	Strong	Yes
13	Overcast	Hot	Normal	Weak	Yes
14	Rain	Mild	High	Strong	No

(b) Find out the class label of the following samples (X1 and X2) (refer to Table 2) using the Naïve Bayesian classifier

X1 = {Outlook= Rain, Temperature=Hot, Humidity=High, Wind=Weak}

X2 = {Outlook= Sunny, Temperature=Cool, Humidity=Normal, Wind=Strong} 6+4

4. (a) Compute A (+) B; where A={(2,1), (3,0.5)} and B={(3,1), (4,0.5)} are fuzzy sets.

(b) What is the importance of the Discernibility Matrix? Explain with the help of an example. 6+4

5. (a) Consider the following set of axioms :

(i) Every child loves Santa

(ii) Everyone who loves Santa loves any reindeer

(iii) Rudolph is a reindeer, and Rudolph has a red nose

(iv) Anything that has a red nose is weird or is a clown

(v) No reindeer is a clown

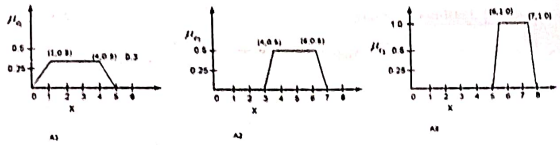
(vi) Scrooge does not love anything weird.

Using resolution, prove that 'Scrooge is not a child'.

(b) Make a comparative study between A* and AO* algorithm. 8+2

Please Turn Over

6. The following figure has three fuzzy sets : A1, A2, and A3. Using the center of gravity method, determine the de-fuzzified value of the aggregated fuzzy set (A1, A2, A3). 10



7. Compute a set of weight values after 1st iteration of the multilayer feed-forward network using backpropagation learning. Consider the model (3-2-2) as a multilayer feed-forward neural network with the following initialization (**Table 3**) : 10

Table - 3

X1	1	input
X2	0	input
X3	1	input
W14	0.2	weight
W15	-0.3	weight
W24	0.4	weight
W25	0.1	weight
W34	-0.5	weight
W35	0.2	weight
W46	-0.3	weight
W56	-0.2	weight
W47	0.3	weight
W57	0.2	weight
$\ominus$4	-0.4	Bias
$\ominus$5	0.2	Bias
$\ominus$6	0.1	Bias
$\ominus$7	-0.2	Bias
H	0.9	Leaning rate
Class label	1	At node 6
	0	At node 7

8. Write short note on the following topics (*any four*) : 2½×4

(a) Pareto-optimal front

(b) SVM

(c) KNN

(d) F-Score

(e) AGNES.