1. Define Image?
An image may be defined as two dimensional light intensity function $f(x, y)$ where $x$ and $y$ denote spatial co-ordinate and the amplitude or value of $f$ at any point $(x, y)$ is called intensity or grayscale or brightness of the image at that point.

2. What is Dynamic Range?
The range of values spanned by the gray scale is called dynamic range of an image. Image will have high contrast, if the dynamic range is high and image will have dull washed out gray look if the dynamic range is low.

3. Define Brightness?
Brightness of an object is the perceived luminance of the surround. Two objects with different surroundings would have identical luminance but different brightness.

4. Define Tapered Quantization?
If gray levels in a certain range occur frequently while others occurs rarely, the quantization levels are finely spaced in this range and coarsely spaced outside of it. This method is sometimes called Tapered Quantization.

5. What do you meant by Gray level?
Gray level refers to a scalar measure of intensity that ranges from black to grays and finally to white.

6. What do you meant by Color model?
A Color model is a specification of 3D-coordinates system and a subspace within that system where each color is represented by a single point.

7. List the hardware oriented color models?
1. RGB model
2. CMY model
3. YIQ model
4. HIS model

8. What is Hue of saturation?
Hue is a color attribute that describes a pure color where saturation gives a measure of the degree to which a pure color is diluted by white light.

9. List the applications of color models?
1. RGB model---used for color monitor & color video camera
2. CMY model---used for color printing
3. HIS model---used for color image processing
4. YIQ model---used for color picture transmission

10. What is Chromatic Adoption?
The hue of a perceived color depends on the adoption of the viewer. For example, the American Flag will not immediately appear red, white, and blue of the viewer has been subjected to high intensity red light before viewing the flag. The color of the flag will appear to shift in hue toward the red component cyan.

11. Define Resolutions?
Resolution is defined as the smallest number of discernible detail in an image. Spatial resolution is the smallest discernible detail in an image and gray level resolution refers to the smallest discernible change is gray level.
12. What is meant by pixel?
A digital image is composed of a finite number of elements each of which has a particular location or value. These elements are referred to as pixels or image elements or picture elements or pels elements.

13. Define Digital image?
When $x$, $y$ and the amplitude values of $f$ all are finite discrete quantities, we call the image digital image.

14. What are the steps involved in DIP?
1. Image Acquisition
2. Preprocessing
3. Segmentation
4. Representation and Description
5. Recognition and Interpretation

15. What is recognition and Interpretation?
Recognition means is a process that assigns a label to an object based on the information provided by its descriptors. Interpretation means assigning meaning to a recognized object.

16. Specify the elements of DIP system?
1. Image Acquisition
2. Storage
3. Processing
4. Display

17. Explain the categories of digital storage?
1. Short term storage for use during processing.
2. Online storage for relatively fast recall.
3. Archival storage for infrequent access.

18. What are the types of light receptors?
The two types of light receptors are
1. Cones and
2. Rods

19. Differentiate photopic and scotopic vision? Photopic vision
The human being can resolve the fine details with these cones because each one is connected to its own nerve end.

Scotopic vision
This is also known as bright light vision. Several rods are connected to one nerve end. So it gives the overall picture of the image. This is also known as thin light vision.

20. How cones and rods are distributed in retina?
In each eye, cones are in the range 6-7 million and rods are in the range 75-150 million.

21. Define subjective brightness and brightness adaptation?
Subjective brightness means intensity as preserved by the human visual system. Brightness adaptation means the human visual system can operate only from scotopic to glare limit. It cannot operate over the range simultaneously. It accomplishes this large variation by changes in its overall intensity.

PART-B
1. Explain various functional block of digital image processing.
2. Briefly explain the elements of human visual system.
3. Describe image formation in the eye with brightness adaptation and discrimination.
4. Explain sampling and quantization.
5. Explain CMY model & explain the RGB model.
6. Explain in detail about basic relationship between Pixels.
UNIT -II IMAGE ENHANCEMENT

PART A

1. Specify the objective of image enhancement technique.
   The objective of enhancement technique is to process an image so that the result is more suitable than the original image for a particular application.

2. Explain the 2 categories of image enhancement.
   i) Spatial domain refers to image plane itself & approaches in this category are based on direct manipulation of picture image.
   ii) Frequency domain methods based on modifying the image by Fourier transform.

3. What is contrast stretching?
   Contrast stretching reduces an image of higher contrast than the original by darkening the levels below m and brightening the levels above m in the image.

4. What is grey level slicing?
   Highlighting a specific range of grey levels in an image often is desired. Applications include enhancing features such as masses of water in satellite imagery and enhancing flaws in x-ray images.

5. Define image subtraction.
   The difference between 2 images f(x,y) and h(x,y) expressed as, g(x,y)=f(x,y)-h(x,y) is obtained by computing the difference between all pairs of corresponding pixels from f and h.

6. What is the purpose of image averaging?
   An important application of image averaging’s in the field of astronomy, where imaging with very low light levels is routine, causing sensor noise frequently to render single images virtually useless for analysis.

7. What is meant by masking?
   Mask is the small 2-D array in which the values of mask co-efficient determine the nature of process. The enhancement technique based on this type of approach is referred to as mask processing.

8. Give the formula for negative and log transformation.
   Negative: S=L-1-r Log: S = c log (1+r) Where c-constant and r 0

9. What is meant by bit plane slicing?
   Instead of highlighting gray level ranges, highlighting the contribution made to total image appearance by specific bits might be desired. Suppose that each pixel in an image is represented by 8 bits. Imagine that the image is composed of eight 1-bit planes, ranging from bit plane 0 for LSB to bit plane-7 for MSB.

10. Define histogram.
    The histogram of a digital image with gray levels in the range [0, L-1] is a discrete function h(rk)=nk. rk-kth gray level nk-number of pixels in the image having gray level rk.

11. What is meant by histogram equalization?
    k k
    Sk= T(rk) = Pr(rj) = nj/n where k=0,1,2,…,L-1 j=0 j=0

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This transformation is called histogram equalization

12. What is the need for transform?
The need for transform is most of the signals or images are time domain signal (ie) signals can be measured with a function of time. This representation is not always best. For most image processing applications anyone of the mathematical transformation are applied to the signal or images to obtain further information from that signal.

13. Define the term Luminance?
Luminance measured in lumens (lm), gives a measure of the amount of energy an observer perceiver from a light source.

14. What is Image Transform?
An image can be expanded in terms of a discrete set of basis arrays called basis images. These basis images can be generated by unitary matrices. Alternatively, a given NxN image can be viewed as an N^2x1 vectors. An image transform provides a set of coordinates or basis vectors for vector space.

15. What are the applications of transform?
1) To reduce band width
2) To reduce redundancy
3) To extract feature.

16. Give the Conditions for perfect transform?
Transpose of matrix = Inverse of a matrix. Orthogonality.

17. What are the properties of unitary transform?
1) Determinant and the Eigen values of a unitary matrix have unity magnitude
2) the entropy of a random vector is preserved under a unitary Transformation
3) Since the entropy is a measure of average information, this means information is preserved under a unitary transformation.

18. Write the steps involved in frequency domain filtering.
1. x+y1. Multiply the input image by (-1) to center the transform.
2. Compute F(u,v), the DFT of the image from (1).
3. Multiply F(u,v) by a filter function H(u,v).
4. Compute the inverse DFT of the result in (3).
5. Obtain the real part of the result in (4). x+y
6. Multiply the result in (5) by (-1)

19. What do you mean by Point processing?
Image enhancement at any Point in an image depends only on the gray level at that point is often referred to as Point processing.

20. Define Derivative filter?

For a function $f(x, y)$, the gradient $f$ at co-ordinate $(x, y)$ is defined as the vector

$$
\nabla f = \frac{\partial f}{\partial x} \hat{i} + \frac{\partial f}{\partial y} \hat{j}
$$

$$
\Delta f = \text{mag} (\nabla f) = \left\{ \left( \frac{\partial f}{\partial x} \right)^2 + \left( \frac{\partial f}{\partial y} \right)^2 \right\}^{1/2}
$$

PART B

1. Explain the types of gray level transformation used for image enhancement.
2. What is histogram? Explain histogram equalization.
3. Discuss the image smoothing filter with its model in the spatial domain.
4. What are image sharpening filters? Explain the various types of it.
5. Explain spatial filtering in image enhancement.
6. Explain image enhancement in the frequency domain.
7. Explain Homomorphic filtering in detail.
UNIT III - IMAGE RESTORATION AND SEGMENTATION

PART A

1. Give the difference between Enhancement and Restoration
   Enhancement technique is based primarily on the pleasing aspects it might present to the viewer. For example: Contrast Stretching. Where as Removal of image blur by applying a deblurring function is considered a restoration technique.

2. What is meant by Image Restoration?
   Restoration attempts to reconstruct or recover an image that has been degraded by using a clear knowledge of the degrading phenomenon.

3. What are the two properties in Linear Operator?
   - Additivity
   - Homogeneity

4. How a degradation process is modeled?
   A system operator $H$, which together with an additive white noise term $n(x,y)$, operates on an input image $f(x,y)$ to produce a degraded image $g(x,y)$.

5. Explain homogeneity property in Linear Operator?
   $H[k1f1(x,y)] = k1 H[f1(x,y)]$
   The homogeneity property says that the response to a constant multiple of any input is equal to the response to that input multiplied by the same constant.

6. Define circulant matrix?
   A square matrix, in which each row is a circular shift of the preceding row and the first row is a circular shift of the last row, is called circulant matrix.

7. What is meant by Noise probability density function?
   The spatial noise descriptor is the statistical behavior of gray level values in the noise component of the model.

8. Why the restoration is called as unconstrained restoration?
   In the absence of any knowledge about the noise ‘$n$’, a meaningful criterion function is to seek an $f^*$ such that $H f^*$ approximates of in a least square sense by assuming the noise term is as small as possible. Where $H =$ system operator. $f^*$ = estimated input image. $g =$ degraded image.

9. Which is the most frequent method to overcome the difficulty to formulate the spatial relocation of pixels?
   The point is the most frequent method, which are subsets of pixels whose location in the input (distorted) and output (corrected) imaged is known precisely.

10. What are the three methods of estimating the degradation function?
    1. Observation
    2. Experimentation

11. What are the types of noise models?
    - Gaussian noise
    - Rayleigh noise
    - Erlang noise

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12. Give the relation for Rayleigh noise?
    Rayleigh noise: The PDF is \( P(Z) = 2(z-a)e^{-(z-a)^2/b} \) for \( Z \geq a \) 0 for \( Z < a \)
    mean \( \mu = a + b/4 \)
    standard deviation \( \sigma^2 = b(4-\mu)/4 \)
13. Give the relation for Gamma noise?
    Gamma noise: The PDF is \( P(Z) = abz^{b-1}e^{-aZ/(b-1)} \) for \( Z \geq 0 \) 0 for \( Z < 0 \)
    mean \( \mu = b/a \)
    standard deviation \( \sigma^2 = b/a^2 \)
14. Give the relation for Exponential noise?
    Exponential noise: The PDF is \( P(Z) = ae^{-az} \) \( Z \geq 0 \) 0
    \( Z < 0 \)
    mean \( \mu = 1/a \)
    standard deviation \( \sigma^2 = 1/a^2 \)
15. Give the relation for Uniform noise?
    Uniform noise: The PDF is \( P(Z) = \frac{1}{b-a} \) if \( a \leq Z \leq b \) 0 otherwise
    mean \( \mu = a + b/2 \)
    standard deviation \( \sigma^2 = (b-a)^2/12 \)
16. Give the relation for Impulse noise?
    Impulse noise: The PDF is \( P(Z) = Pa \) for \( z = a \) \( Pb \) for \( z = b \) 0 Otherwise
17. What is meant by blind image restoration?
    Information about the degradation must be extracted from the observed image either
    explicitly or implicitly. This task is called as blind image restoration.
18. What are the two approaches for blind image restoration?
    (i) Direct measurement (ii) Indirect estimation
19. What is meant by direct measurement?
    In direct measurement the blur impulse response and noise levels are first estimated from an
    observed image where this parameter is utilized in the restoration.
20. What is blur impulse response and noise levels?
    Blur impulse response:
    This parameter is measured by isolating an image of a suspected object within a picture.
    Noise levels: The noise of an observed image can be estimated by measuring the image covariance
    over a region of constant background luminance.

PART B
1. What is the use of Wiener filter in image restoration? Explain.
2. What is meant by inverse filtering? Explain.
3. Explain singular value decomposition and specify its properties.
4. Explain image degradation model / restoration process in detail.
5. What are the two approaches for blind image restoration? Explain in detail.
6. Discuss about Constrained least square restoration for a digital image in detail.
7. What is image restoration? Explain the degradation model for continuous function in detail.
8. Discuss about region based image segmentation techniques. Compare threshold region based techniques.
9. Explain the two techniques of region representation
10. Explain the segmentation techniques that are based on finding the regions directly
UNIT IV - WAVELETS AND IMAGE COMPRESSION

PART A

1. What is image compression?
   Image compression refers to the process of redundancy amount of data required to represent the given quantity of information for digital image. The basis of reduction process is removal of redundant data.

2. What is Data Compression?
   Data compression requires the identification and extraction of source redundancy. In other words, data compression seeks to reduce the number of bits used to store or transmit information.

3. What are two main types of Data compression?
   (i) Lossless compression can recover the exact original data after compression. It is used mainly for compressing database records, spreadsheets or word processing files, where exact replication of the original is essential.
   (ii) Lossy compression will result in a certain loss of accuracy in exchange for a substantial increase in compression. Lossy compression is more effective when used to compress graphic images and digitised voice where losses outside visual or aural perception can be tolerated.

4. What is the need for Compression?
   In terms of storage, the capacity of a storage device can be effectively increased with methods that compress a body of data on its way to a storage device and decompresses it when it is retrieved. In terms of communications, the bandwidth of a digital communication link can be effectively increased by compressing data at the sending end and decompressing data at the receiving end.

   At any given time, the ability of the Internet to transfer data is fixed. Thus, if data can effectively be compressed wherever possible, significant improvements of data throughput can be achieved. Many files can be combined into one compressed document making sending easier.

5. What are different Compression methods?
   - Run Length Encoding (RLE) Arithmetic coding
   - Huffman coding and Transform coding

6. Define is coding redundancy?
   If the gray level of an image is coded in a way that uses more code words than necessary to represent each gray level, then the resulting image is said to contain coding redundancy.

7. Define interpixel redundancy?
   The value of any given pixel can be predicted from the values of its neighbors. The information carried by is small. Therefore the visual contribution of a single pixel to an image is redundant. Otherwise called as spatial redundant geometric redundant or...
8. What is run length coding?
Run-length Encoding, or RLE is a technique used to reduce the size of a repeating string of characters. This repeating string is called a run; typically RLE encodes a run of symbols into two bytes, a count and a symbol. RLE can compress any type of data regardless of its information content, but the content of data to be compressed affects the compression ratio. Compression is normally measured with the compression ratio:

Compression Ratio = original size / compressed size: 1

10. Define psycho visual redundancy?
In normal visual processing certain information has less importance than other information. So this information is said to be psycho visual redundant.

11. Define encoder
Source encoder is responsible for removing the coding and interpixel redundancy and psycho visual redundancy.
There are two components A) Source Encoder B) Channel Encoder

12. Define source encoder
Source encoder performs three operations

1) Mapper -this transforms the input data into non-visual format. It reduces the interpixel redundancy.
2) Quantizer - It reduces the psycho visual redundancy of the input images .This step is omitted if the system is error free.
3) Symbol encoder- This reduces the coding redundancy .This is the final stage of encoding process.

13. Define channel encoder
The channel encoder reduces reduces the impact of the channel noise by inserting redundant bits into the source encoded data. Eg: Hamming code

14. What are the types of decoder?
Source decoder- has two components
a) Symbol decoder- This performs inverse operation of symbol encoder.
b) Inverse mapping- This performs inverse operation of mapper. Channel decoder-this is omitted if the system is error free.

15. What are the operations performed by error free compression?
1) Devising an alternative representation of the image in which its interpixel redundant are reduced.
2) Coding the representation to eliminate coding redundancy

16. What is Variable Length Coding?
Variable Length Coding is the simplest approach to error free compression. It reduces only the coding redundancy. It assigns the shortest possible codeword to the most probable gray levels.

17. **Define Huffman coding**

Huffman coding is a popular technique for removing coding redundancy. When coding the symbols of an information source the Huffman code yields the smallest possible number of code words, code symbols per source symbol.

18. **Define Block code**

Each source symbol is mapped into fixed sequence of code symbols or code words. So it is called as block code.

19. **Define instantaneous code**

A code word that is not a prefix of any other code word is called instantaneous or prefix codeword.

20. **Define uniquely decodable code**

A code word that is not a combination of any other codeword is said to be uniquely decodable code.
21. What is bit plane Decomposition?
An effective technique for reducing an image’s interpixel redundancies is to process the image’s bit plane individually. This technique is based on the concept of decomposing multilevel images into a series of binary images and compressing each binary image via one of several well-known binary compression methods.

22. Define B2 code
Each code word is made up of continuation bit c and information bit which are binary numbers. This is called B2 code or B code. This is called B2 code because two information bits are used for continuation bits.

23. What is JPEG?
The acronym is expanded as "Joint Photographic Expert Group". It is an international standard in 1992. It perfectly Works with color and grayscale images. Many applications e.g., satellite, medical.

24. What are the basic steps in JPEG?
The Major Steps in JPEG Coding involve:
DCT (Discrete Cosine Transformation)
Quantization
Zigzag Scan_ DPCM on DC component
RLE on AC Components
Entropy Coding

25. What is MPEG?
The acronym is expanded as "Moving Picture Expert Group". It is an international standard in 1992. It perfectly Works with video and also used in teleconferencing Input image Wavelet transform.

26. What is zig zag sequence?
The purpose of the Zig-zag Scan: To group low frequency coefficients in top of vector. Maps 8 x 8 to a 1 x 64 vector

PART B
1. What is data redundancy? Explain three basic data redundancy?
2. Explain about Multiresolution Expansions in detail.
3. What is image compression? Explain any four variable length coding compression schemes.
4. Explain about Image compression model?
5. The source Encoder and Decoder
6. The channel Encoder and Decoder
7. Explain about Error free Compression?
8. Explain about Lossy compression?
9. Differentiate between lossless and lossy compression and explain transform coding system with a neat diagram.
UNIT V- IMAGE REPRESENTATION AND RECOGNITION

PART A

1. Define chain codes?

Chain codes are used to represent a boundary by a connected sequence of straight line segment of specified length and direction. Typically this representation is based on 4 or 8 connectivity of the segments. The direction of each segment is coded by using a numbering scheme.

2. What are the demerits of chain code?

The resulting chain code tends to be quite long. Any small disturbance along the boundary due to noise cause changes in the code that may not be related to the shape of the boundary.

3. What is thinning or skeletonizing algorithm?

An important approach to represent the structural shape of a plane region is to reduce it to a graph. This reduction may be accomplished by obtaining the skeletonizing algorithm. It play a central role in a broad range of problems in image processing, ranging from automated inspection of printed circuit boards to counting of asbestos fibers in air filter.

4. Specify the various image representation approaches

- Chain codes
- Polygonal approximation
- Boundary descriptors.

5. What is polygonal approximation method?

Polygonal approximation is an image representation approach in which a digital boundary can be approximated with arbitrary accuracy by a polygon. For a closed curve the approximation is exact when the number of segments in polygon is equal to the number of points in the boundary so that each pair of adjacent points defines a segment in the polygon.

6. Specify the various polygonal approximation methods

- Minimum perimeter polygons merging techniques
- Splitting techniques

7. Name few boundary descriptors

- Simple descriptors
- Shape numbers
- Fourier descriptors

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8. Give the formula for diameter of boundary

The diameter of a boundary $B$ is defined as $\text{Diam} (B) = \max [D (p_i, p_j)]$ where $D$-distance measure $p_i, p_j$-points on the boundary.


The length of a boundary is the number of pixels along a boundary. Eg. for a chain coded curve with unit spacing in both directions the number of vertical and horizontal components plus twice the number of diagonal components gives its exact length.

10. Define eccentricity and curvature of boundary

Eccentricity of boundary is the ratio of the major axis to minor axis. Curvature is the rate of change of slope.

11. Define shape numbers

Shape number is defined as the first difference of smallest magnitude. The order $n$ of a shape number is the number of digits in its representation.

12. Give the Fourier descriptors for the following transformations

(1) Identity (2) Rotation (3) Translation (4) Scaling (5) Starting point

13. Specify the types of regional descriptors

Simple descriptors Texture

14. Name few measures used as simple descriptors in region descriptors

Area Perimeter Compactness

Mean and median of gray levels Minimum and maximum of gray levels

Number of pixels with values above and below mean

15. Define compactness

Compactness of a region is defined as $(\text{perimeter})^2/\text{area}$. It is a dimensionless quantity and is insensitive to uniform scale changes.
16. Describe texture

Texture is one of the regional descriptors. It provides measures of properties such as smoothness, coarseness and regularity. There are 3 approaches used to describe texture of a region.

They are (i) structural (ii) spectral (iii) statistical

17. Describe statistical approach

Statistical approaches describe smooth, coarse, grainy characteristics of texture. This are the simplest one compared to others. It describes texture using statistical moments of the gray-level histogram of an image or region.

18. Define gray-level co-occurrence matrix.

A matrix C is formed by dividing every element of A by n (A is a k x k matrix and n is the total number of point pairs in the image satisfying P(position operator). The matrix C is called gray-level co-occurrence matrix if C depends on P, the presence of given texture patterns may be detected by choosing an appropriate position operator.

19. Explain structural and spectral approach

Structural approach deals with the arrangement of image primitives such as description of texture based on regularly spaced parallel lines.

Spectral approach is based on properties of the Fourier spectrum and is primarily to detect global periodicity in an image by identifying high energy, narrow peaks in spectrum. There are 3 features of Fourier spectrum that are useful for texture description.

They are:

- Prominent peaks in spectrum gives the principal direction of texture patterns.
- The location of peaks in frequency plane gives fundamental spatial period of patterns. Eliminating any periodic components by our filtering leaves non-periodic image elements.

20. Define pattern.

A pattern is a quantitative or structural description of an objective or some other entity of interest in an image.

21. Define pattern class.

A pattern class is a family of patterns that share some common properties. Pattern classes are denoted w1, w2, ----wm, where M is the number of classes.

22. List the three pattern arrangements.

Vectors Strings Treestching
23. **Give the decision theoretic methods.**
   Matching-Matching by minimum distance classifier matching by correlation

24. **Define training pattern and training set.**
   The patterns used to estimate the parameters are called training patterns, and a set of such patterns from each class is called a training set.

25. **Define training**
   The process by which a training set is used to obtain decision functions is called learning or training.

26. **What are the layers in back propagation network?**
   Input layer, Hidden layer and output layer

**PART B**

1. **Define and explain the various representation approaches?**

2. **Polygon approximations**

3. **Explain Boundary descriptors in detail with a neat diagram.**

4. **Explain regional descriptors.**

5. **Explain about patterns and pattern classes.**

6. **Explain about Recognition based on matching.**