1. What is the difference between lossy and lossless compression?
    Select one:
    a. Lossy coding takes advantage of statistical dependencies and the lossless takes into account the properties of the receiver.
    b. Lossless coding takes advantage of statistical dependencies and the lossy takes into account the properties of the receiver.
    Ans. Lossless coding takes advantage of statistical dependencies and the lossy takes into account the properties of the receiver.

2. Which colours are called primary?
    Select one:
    a. red, black, green
    b. red, green, blue
    c. red, green, white
    Ans. red, green, blue

3. What is the order of the primary colours in the OpenCV library of Python? (In the answer R stand for red, G-green and B-blue)
    Select one:
    a. BRG
    b. RGB
    c. BGR
    Ans. BGR

4. How can we invert a matrix in Python? For example, if we have a matrix given as:
    A=np.matrix([[1,2],[3,4]])
    Select one or more:
    a. from scipy import linalg
    linalg.inv(A)
    b. from numpy import *
    A.I
    c. pow(A,1)
    Ans. from scipy import linalg linalg.inv(A), from numpy import * A.I

5. Which photoreceptor cells are the most sensitive to the luminance?
    Select one:
    a. Ganglion cells
    b. Cones
    c. Rods
    Ans. Rods

6. Human beings are the most sensitive to the green colour. (according to the plot of spectral sensitivity of the eye in Lecture 2)
    Select one:
    True
    False
    Ans. True

7. What is represented by the CIE colour space?
    Select one:
    a. It represents the colour spectrum visible to the average human being.
    b. It represents only the RGB colour space.
    Ans. It represents the colour spectrum visible to the average human being.

8. When transmitting/encoding video files, less spatial resolution is given to the colour components. This is since human beings have only 6 million cones, so the eye is less sensitive to the spatial changes in colour when compared to the luminance.

Select one:
True
False
Ans. True

9. In which order should we perform up/downsampling and filtering to avoid aliasing?
Select one or more:

a. 1.upsampling 2.filtering
b. 1.filtering 2. downsampling
c. 1. Downsampling 2.filtering
d. 1.filtering 2.upsampling
Ans. 1.filtering 2. downsampling, 1.upsampling 2.filtering

10. Imagine you have the following array (in Python notation) x=np.array([[9,1; 3,6; 4,0], [8,1; 2,6; 6,5]]). Calculate 2D-DFT for this sequence and provide the first sample of the resulting spectrum X(0,0) in the answer field.

Ans. 33.9

Q.10 2D - DFT

$$X(k_1,k_2)=\sum_{n_1=0}^{N_1-1}\sum_{n_2=0}^{N_2-1} x(n_1,n_2)\cdot e^{-j\frac{\pi}{N_1}\cdot k_1 n_1}\, e^{-j\frac{\pi}{N_2}\cdot k_2 n_2}$$

where $0 \le k_1 \le N_1$ and $0 \le k_2 < N_2$

$$\Rightarrow x = \begin{bmatrix} 9.1 & 3.6 & 4.0 \\ 8.1 & 2.6 & 6.5 \end{bmatrix}$$

$$X(0,0) = \sum_{n_1=0}^{N_1-1}\sum_{n_2=0}^{N_2-1} x(n_1,n_2)\cdot 1.1$$

$$= x(0,0) + x(0,1) + x(0,2) + x(1,0) + x(1,1) + x(1,2)$$

$$= 9.1 + 3.6 + 4.0 + 8.1 + 2.6 + 6.5$$

$$= \boxed{33.9}$$

11. Compute the 2D z-Transform of the following 2x2 image block, for z1=9,3 and z2=9,1:

7.6, 7.3
1.5, 9.5
Ans. 8.68

Q11 2D Z-Transform

$$\begin{bmatrix} 7.6 & 7.3 \\ 1.5 & 9.5 \end{bmatrix}$$

$$X(n_1,n_2) = \sum_{n_1=0}^{N-1} \sum_{n_2=0}^{M-1} x(n_1,n_2)\, z_1^{-n_1} z_2^{-n_2}$$

$z_1 = 9.3$ $\quad z_2 = 9.1$

Ans.
$$= \sum_{n_1=0}^{2-1} \sum_{n_2=0}^{2-1} x(n_1,n_2)\,(9.3)^{-n_1}\,(9.1)^{-n_2}$$

$$= x(0,0)(9.3)^0(9.1)^0 + x(0,1)(9.3)^0(9.1)^{-1} + x(1,0)(9.3)^{-1}(9.1)^0 + x(1,1)(9.3)^{-1}(9.1)^{-1}$$

$$\Rightarrow 7.6 \times 1 \times 1 + (7.3)(1)\left(\frac{1}{9.1}\right) + (1.5) \times \left(\frac{1}{9.3}\right) \times (1) + (9.5)\left(\frac{1}{9.3}\right)\left(\frac{1}{9.1}\right)$$

$$\Rightarrow 7.6 + 0.80 + 0.16 + \frac{9.5}{84.63}$$

$$\Rightarrow 8.56 + 0.112 = \underline{8.67}$$

12. Calculate Z-transform for the following sequence x(n)=[1,2; 6,0; 8,8; 9,0] and z=2,7.

Ans. 5.07

Q.12

$x(n) = [1.2, 6.0, 8.8, 9.0]$

$z = 2.7$

$$X(z) = \sum_{n=0}^{N-1} x(n)\, z^{-n}$$

$$= \cancel{\sum_{n=0}^{3} x(1.2, 6.0, 8.8, 9.0) z^{-}}$$

$$= \Rightarrow x(0) z^{-0} + x(1) z^{-1} + x(2) z^{-2} + x(3) z^{-3}$$

$$\Rightarrow 1.2 \times 2.7^{-0} + 6.0 \times 2.7^{-1} + 8.8 \times 2.7^{-2} + 9.0 \times 2.7^{-3}$$

$$\Rightarrow 1.2 + \frac{6.0}{2.7} + \frac{8.8}{2.7 \times 2.7} + \frac{9.0}{2.7 \times 2.7 \times 2.7}$$

$$\Rightarrow 1.2 + 2.22 + \frac{8.8}{7.29} + \frac{9.0}{19.68}$$

$$\Rightarrow 3.42 + 1.20 + 0.45$$

$$\Rightarrow \boxed{5.07}$$

13. Imagine you have two following sequences:

x(m)=[9,8; 9,1; 7,1; 5,1]

h(m)=[7,6; 3,2; 7,0; 6,4]

Convolve this two sequences provide the first number in the answer field.

Ans. 74.48

Q.13 $x(m) * h(m) = \sum_{k=0}^{\infty} x(k)\, h(m-k)$

$x(0) * h(0) \Rightarrow \sum_{k=0} x(0)\, h(0)$

$\Rightarrow 9.8 \times 7.6 = 74.48$

//

14. Compute the 2D convolution for the following two image blocks and provide x(0,1) (the second sample in the first row):

8,7	7,3	2,1	6,2
3,1	3,8	8,3	1,9

Ans. 69.27

Q.14 $x(n_1,n_2) = \sum_{k_1=0}^{\infty} \sum_{k_2=0}^{\infty} x(k_1,k_2)\, h(n_1-k_1, n_2-k_2)$

$x(0,1) = x(0,0)\, h(0,1) + x(0,1)\, h(0,0)$

$= 8.7 \times 6.2 + 7.3 \times 2.1$

$= 53.94 + 15.33$

$= 69.27$

15. Assume we have a DCT type 2 transform for N=8 subbands. Determine its equivalent filters. What is sample 4 of subband 6 of the impulse response for the equivalent filter bank on the synthesis side? (We start the indices with 0, as in the Lecture 4.)

Ans. -0,19

16. The eye of human beings is the most sensitive to the temporal frequency of around 15 Hz.

Select one:

True

False

Ans. True

17. Imagine we have a filter bank, where the downsampling factor is 6. The filter bank will be critically sampled if the number of subbands is equal to…

Ans. 6

18. When searching for the fitting motion vectors, the goal is to have the smallest MAE or MSE values between the original and the estimated images (blocks).

Select one:

True

False

Ans. True

19. Calculate the Mean Squared Error (MSE) for the following sequence: 1; 2; 3; 4; if the decoded sequence is:

6.8, 6.3, 8.6, 1.0

Ans. 23.16

Q.19 Mean Square Error $= \frac{1}{N}\sum_{0}^{N-1}(C_i-R)^2$

$$= \frac{1}{4}\sum_{0}^{3}(C-R)^2$$

$$= \frac{1}{4}[(6.8-1)^2+(6.3-2)^2+(8.6-3)^2+(1.0-4)^2]$$

$$\Rightarrow \frac{1}{4}[(5.8)^2+(4.3)^2+(5.6)^2+(-3)^2]$$

23.12

20. The spiral order search for the most fitting motion vectors has no drawbacks.

Select one:
True
False
Ans. False

21. KLT is not used in practice because it does not have a fast implementation and because it requires the transmission of side information.

Select one:
True
False
Ans. True

22. When uncorrelatedness leads to independence?

Select one:
Non-gaussian distributed signals
Gaussianity does not matter
Gaussian distributed signals
Ans. Gaussian distributed signals

23. Usage of an optimum transform matrix will result in a decreased bit rate.

Select one:
True
False
Ans. True

24. The following 2x2 image block is given:

1,3; 6,5;
5,0; 4,0.
What is the DC coefficient of its resulting 2x2 WHT?
Ans. 8,40

Q.24 DC coefficient of 2x2 WHT

$$x \begin{bmatrix} 1.3 & 6.5 \\ 5.0 & 4.0 \end{bmatrix} \qquad WHT = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

$$\Rightarrow \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} 1.3 & 6.5 \\ 5.0 & 4.0 \end{bmatrix} \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

$$\Rightarrow \frac{1}{2} \begin{bmatrix} 6.3 & 10.5 \\ -3.7 & 2.5 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \Rightarrow \frac{6.3+10.5}{2} = \boxed{8.4}$$

25. Which condition should be fulfilled for matrix T to be orthonormal?
Select one or more:

$T^{-1} = T^T$

$T^{-1} = T^H$

Ans. $T^{-1} = T^T$ and $T^{-1} = T^H$

26. Given is the autocorrelation matrix A_xx=

9.4 0
0 18.8

Calculate the KLT transform matrix and provide the first element of the resulting matrix.

Ans. 1,00

27. Imagine given picture block X=

5.6 7.1 3.5 9.9
5.8 1.0 9.4 9.3
9.0 3.4 4.8 5.4
9.2 2.5 9.2 1.2

Calculate the DCT integer transform of H.264 and provide the first value of the resulting matrix. (Hint use rounded H matrix defined in Lecture 9. Also, note here encoder takes a transpose of the usual transform.)

Ans. 96,30

28. In H264 WHT was preferred over integer DCT, because it is simpler to implement and required fewer bits.

Select one:
True
False
Ans. True

29. Motion JPEG is an image coder, which does not use motion compensation, but encodes each frame individually as a JPEG image.

Select one:
True
False
Ans. False

30. One of the important features of H264 is the algorithm which allows reducing the artifacts, appearing on the block boundaries.

Select one:
True

False
Ans. True

31. Nested quadtree structure allows having a variable block transform size. This has the advantage of adapting to the image content.

Select one:
True
False
Ans. True

32. Videos with higher resolution...

Select one or more:
a. contain less smooth areas.
b. provide more pixels with similar values which results in more redundancy between them.
c. require more sophisticated tools to achieve a higher quality
Ans. require more sophisticated tools to achieve higher quality, provide more pixels with similar values which results in more redundancy between them.

33. Angular prediction is the most suitable for the even patterns.

Select one:
True
False
Ans. False

34. Imagine we are considering the case of planar coding and want to calculate the value of the bottom pixel as shown in Figure 5 in Lecture 13. The value of the rightmost lowest pixel of the previous block is 46 and the transmitted rightmost is 153. What will be the value of the 6th pixel located on the bottom? Use the linear interpolation (see also Lecture 6b the last example).
Hint: choose the parameter u to be determined between 0 and 1, linear interpolation is then defined as y=au+b.

Ans. 126.25

2.34

Linear Interpolation

$u = 0 \rightarrow 1 \Rightarrow \frac{6}{8} = \frac{3}{4}$

$\Rightarrow f(0)(1-u) + f(1)(u)$

$= 46\left(1-\frac{3}{4}\right) + 153\left(\frac{3}{4}\right)$

$\Rightarrow 46 \times \frac{1}{4} + 153 \times \frac{3}{4}$

$= 11.5 + 114.75 = \boxed{126.25}$

35. Assume we have a block above the current block which has as in its lowest row as the first 2 pixels the values 2,1 and 4,1 (see Lecture 13). We use angular prediction with an angle of +1 pixel (measured from the lowest row of the block).
What is the angular predicted value for the leftmost 4th pixel from the top of the current block?

Ans. 3.1

36. Given are the following pixel values:

5,6;2,4;7,4;

Apply a B-Spline interpolation. What is the new value at the position of the centre value?

Ans. 3.7666

Q. 36 B-Spline Interpolation

$$= \frac{1a}{6} + \frac{4b}{6} + \frac{1c}{6}$$

$$\Rightarrow \frac{1}{6} \times 5.6 + \frac{4}{6} \times 2.4 + \frac{1}{6} \times 7.4$$

$$= 0.933 + 1.6 + 1.233 = \boxed{3.7666}$$

37. Imagine we have two neighbouring pixels, f(0)=9 and f(1)=16. What is the sample on the distance 0,0 between these two pixels, using linear interpolation?

Ans. 9.0

Q.37 Distance = 0.0

$f(0) = 9$ $f(1) = 16$

sample value $= (9)(1-0) + (16)(0)$

$= \boxed{9}$