Exam instruction

- The exam contains 6 questions.
- You are required to answer only 5 questions.
- Read questions carefully and answer what is asked for.
- If something is unclear, make the assumptions you need to clarify it and be sure to write down your assumptions.
- Do your own work.

Good luck
**Question 1**

A. **State whether the following statements is True or False, incorrect answers may cancel (delete) correct** (10 pts.).

1. Lumen is a unit of light flow
2. Sensor strips mounted in a ring configuration are used in medical and industrial imaging to obtain cross-sectional (“slice”) images of 3-D objects
3. An image with low contrast has wide histogram distribution
4. The idea behind contrast stretching is to increase the dynamic range of the gray levels in the image being processed
5. High-boost filtering gives us the flexibility to decrease the contribution made by the image to overall enhanced result.
6. A Degradation is defined at points for which \( H(u,v) \) is down to a certain fraction of its maximum value
7. Convolution is same as correlation except that, the filter is first rotated by 180 degree
8. Power-law function maps a narrow range of low gray-level values in the input image into a wider range of output levels.
9. Single valued is required to guarantee the inverse transformation will exist
10. Laplacian filter replaces the pixel value by the median value in the neighborhood

B. **Short answer questions**

1. What is the definition of image? (2.5 pts.)

2. Define the Bit-Plane slicing. (2.5 pts.)

3. If the pixels in an image are shuffled (reordered), will there be any change in the histogram? Justify your answer (2.5 pts.)

4. What is an “ideal low-pass filter”? Is this filter suitable to use in terms of image processing? (2.5 pts.)
Question 2
Suppose that you have been given the 3-bit 4x4 image shown in the figure below.

\[
\begin{array}{cccc}
0 & 0 & 0 & 4 \\
1 & 1 & 1 & 5 \\
1 & 2 & 2 & 7 \\
2 & 2 & 2 & 7 \\
\end{array}
\]

A. Show the output image as a result of histogram equalization. (10 pts.)

B. Using the same image matrix as in the previous example, show the output image as the desired histogram is as follows: (10 pts.)

\[
\begin{array}{cccc}
& 3 & 3 & 3 \\
2 & & & & 2 & 1 & 1 & 1 \\
0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\
\end{array}
\]
Question 3
A. Given an image of size 4x4, 4- bits passes through an intensity transformation function
given by:

\[ s = T(r) = \alpha \log_2(1 + r) + \beta \]

Where \( \alpha \) and \( \beta \) are constants, few pixels are available in the input and output images, as shown below.

<table>
<thead>
<tr>
<th>3</th>
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<tbody>
<tr>
<td>9</td>
<td>15</td>
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<tr>
<td>A</td>
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<td>1</td>
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input image

<table>
<thead>
<tr>
<th>5</th>
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<tr>
<td>11</td>
<td>9</td>
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<tr>
<td>3</td>
<td>8</td>
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<tr>
<td>B</td>
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output image

What are the values of the pixels A and B in the input and output images respectively? (10 pts.)

B. Given an image of size 3x3 as \( f(x,y) \), determine the output image \( g(u,v) \) using
Logarithmic transformation

\[ g(u,v) = |c \log_{10}(1+f(x,y))| \]

By choosing \( c \) as

1) \( c = 1 \) (5 pts.)
2) \( c = L/ (\log_{10}(1+L)) \) (5 pts.)

<table>
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<tr>
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Question 4
Filter the given 4x4 gray level image with
A. 3x3 mean filter using zero padding. (10 pts.)
B. Laplacian filter with given mask and reflecting the border pixels. (10 pts.)

\[
\omega_d = \begin{pmatrix}
0 & 1 & 0 \\
1 & -4 & 1 \\
0 & 1 & 0
\end{pmatrix}.
\]

\[
\begin{array}{cccc}
1 & 2 & 4 & 5 \\
5 & 2 & 5 & 5 \\
1 & 1 & 3 & 6 \\
2 & 4 & 6 & 7
\end{array}
\]
Question 5
Given an input image of size 7 x 7 shown below, was filtered using 3 x 3 adaptive median filter with maximum allowed size of 5 x 5.

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Input Image

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<th>Value</th>
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<tr>
<td>x</td>
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<tr>
<td>y</td>
<td></td>
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<td>z</td>
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Output Image

A. What is the value of the pixel A in the input image? (5 pts.)
B. What are the values of the pixels x, y, and z in the output image? (15 pts.)
**Question 6**

In the figure below, when the image on the left was filtered using a smoothing filter, the result was the image on the right. The filter used was one of these: 1. averaging filter; 2. ideal lowpass filter; 3. Gaussian lowpass filter; 4. median filter. The small black square on the lower right hand corner of the original image shows the size of the mask that was used. That small square is not part of the image.

(a) original image  
(b) filtered image

a) For each of the four possible filters listed above, give at least one reason why you think it was, or was not, the filter actually used. (10 pts.)

b) If the size of the mask were tripled, and the same filter you selected in (a) used, how would the appearance of the image after filtering be changed? (10 pts.)