



COMSATS University Islamabad, Lahore Campus
Department of Electrical and Computer Engineering

Mid Term Examination – SPRING 2023

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|-----------------|--------------------------|---------------|-------------------------|---------------|--------|
| Course Title: | Digital Image Processing | Course Code: | CPE 415 | Credit Hours: | 4(3,1) |
| Course | Dr. Ikramullah Khosa | Program Name: | BE Computer Engineering | | |
| Semester: | 8 th | Batch: | FA19-BCE | Section: | A/B |
| | | Date: | 03-05-2023 | | |
| Time Allowed: | 90 Minutes | | Maximum Marks: | 25 | |
| Student's Name: | | Reg. No. | CIIT/ | /LHR | |

Important Instructions / Guidelines:

- This is a closed-book, closed-notes examination.

Question 1 (CLO-1, PLO-1, C3)

(08 Marks)

Apply the concepts of image fundamentals and image enhancement to solve the following questions.

- A. A sample row consisting gray levels of four pixels is shown. Compute the value of new samples by performing linear interpolation at 1/4 pixel. (Round-off the answer to nearest integer value) (6 Marks)

| | | |
|---|----|---|
| 3 | 10 | 2 |
|---|----|---|

- B. A CCD chip of dimension 14×14 mm and having 2048×2048 elements is focused on a square, flat area, located 0.5 m away. How many line pairs per mm will this camera be able to resolve? The camera is equipped with a 35 mm lens. (2 Marks)

Question 2 (CLO-1, PLO-1, C3)

(17 Marks)

Relate the concepts of image enhancement in spatial and frequency domain to solve the following questions.

- A. Following row represents the gray levels of a 3-bit gray scale image. Produce the first and second derivative. Also show the mathematical expression used for computation of derivatives. (6 Marks)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 5 | 6 | 7 | 7 | 0 | 6 | 5 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|---|

- B. The gray level probabilities of a 3-bit image are shown in the following table. Show the gray level probability histogram. Perform histogram equalization. Compute and show the equalized histogram. Also show the transformation function. (5 Marks)

| r_k | n_k | $p_r(r_k) = n_k/MN$ |
|-----------|-------|---------------------|
| $r_0 = 0$ | 790 | 0.19 |
| $r_1 = 1$ | 1023 | 0.25 |
| $r_2 = 2$ | 850 | 0.21 |
| $r_3 = 3$ | 656 | 0.16 |
| $r_4 = 4$ | 329 | 0.08 |
| $r_5 = 5$ | 245 | 0.06 |
| $r_6 = 6$ | 122 | 0.03 |
| $r_7 = 7$ | 81 | 0.02 |

- C. Show that subtracting a Laplacian from an image is proportional to unsharp masking i.e. (4 Marks)

$$f(x,y) - \nabla^2 f(x,y) \sim f(x,y) - \bar{f}(x,y)$$

- D. Consider a checkerboard image in which each square is 0.5×0.5 mm. Assuming that the image extends infinity in both coordinate directions, what is the minimum sampling rate (sample/mm) required to avoid Aliasing? (2 Marks)