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SEMESTER 2 EXAMINATIONS 2021/2022

MODULE: CA4007 - Computer Graphics and Image Processing

PROGRAMME(S):

CASE	BSc in Computer Applications (Sft.Eng.)
ECSAO	Study Abroad (Engineering & Computing)
ECSA	Study Abroad (Engineering & Computing)

YEAR OF STUDY: 4,O,X

EXAMINER(S):

Dr. Hossein Javidnia (Internal) (Ext:6565)

EXAM NUMBER: _____ **SEAT NUMBER:** _____

TIME ALLOWED: 3 Hours

INSTRUCTIONS: **Answer all questions.**

PLEASE DO NOT TURN OVER THIS PAGE UNTIL YOU ARE INSTRUCTED TO DO SO.

The use of programmable or text storing calculators is expressly forbidden.

Requirements for this paper:

1. ***Exam Paper to be returned with Booklet***

QUESTION 1 ***[TOTAL MARKS: 5]***

For the 4×4 image A calculate the normalized histogram. You must show the calculations.

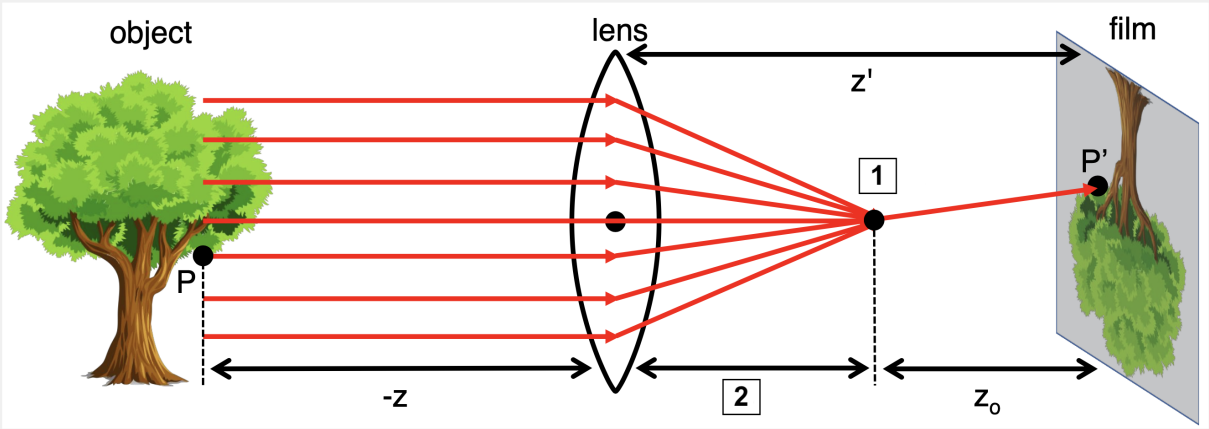
$A =$

2	4	5	2
1	2	6	3
4	2	5	6
3	1	4	0

[End of Question 1]

QUESTION 2 ***[TOTAL MARKS: 5]***

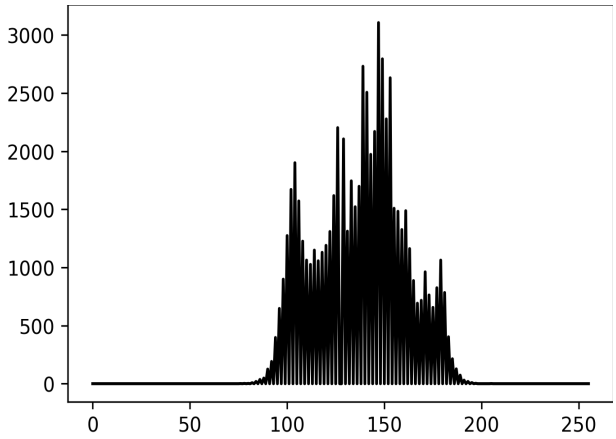
In the following diagram, name parameters $\boxed{1}$ and $\boxed{2}$.



[End of Question 2]

QUESTION 3 ***[TOTAL MARKS: 7.5]***

Explain why the following histogram has such a distribution and how it can be fixed.



[End of Question 3]

QUESTION 4 ***[TOTAL MARKS: 5]***

Which statement is correct?

- ◯ The larger the focal length, the larger the depth of field.
- ◯ The shorter the focal length, the larger the depth of field.
- ◯ The shorter the focal length, the shorter the depth of field
- ◯ There is no correlation between focal length and depth of field.

[End of Question 4]

QUESTION 5 ***[TOTAL MARKS: 10]***

Apply a 3×3 median filter to image B with 5×5 pixel resolution and provide the output. Zero padding must be used. Show the calculation process.

$B =$

12	3	4	53	23
3	44	8	7	43
87	3	1	54	0
32	5	43	66	98
81	22	6	73	23

[End of Question 5]

QUESTION 6 ***[TOTAL MARKS: 7.5]***

Q 6(a) **[2.5 Marks]**
What is Ray Tracing?

Q 6(b) **[2.5 Marks]**
Describe how Ray Tracing works.

Q 6(c) **[2.5 Marks]**
Why is Ray Tracing used in computer graphics?

[End of Question 6]

QUESTION 7 ***[TOTAL MARKS: 7.5]***

Consider the 2D point $A = (3, 4)$. Translate point A to point $p = (5, 6)$, apply a rotation by $\theta = 30°$ and bring back the point to the original coordinates system. Show the calculation process.

$sin(rad(30°)) = 0.5$
$cos(rad(30°)) = 0.8$

[End of Question 7]

QUESTION 8 ***[TOTAL MARKS: 5]***

In the generic shading model which includes Lambertian, Blinn-Phong and Ambient, what are the parameters k_a, k_d and k_s?

$$L = k_a I_a + k_d I max(0, \mathbf{n} \cdot \mathbf{l}) + k_s I max(0, \mathbf{n} \cdot \mathbf{h})^n$$

- ◯ Diffuse coefficient, Specular coefficient, Ambient coefficient.
- ◯ Ambient coefficient, Diffuse coefficient, Specular coefficient.
- ◯ Specular color, Ambient color, Reflectance color.
- ◯ Reflectance color, Specular color, Ambient color.

[End of Question 8]

QUESTION 9 ***[TOTAL MARKS: 7.5]***

Describe the Bilateral filter and its two parameters and how they influence the outcome of the filtering process.

[End of Question 9]

QUESTION 10 ***[TOTAL MARKS: 10]***

Q 10(a) **[5 Marks]**

What are advantages in image processing of working in the frequency domain rather than the spatial domain?

Q 10(b) **[5 Marks]**

Describe specifically how we can use frequency-domain methods to perform a spatial convolution.

[End of Question 10]

QUESTION 11 ***[TOTAL MARKS: 10]***

Q 11(a) **[5 Marks]**

What does the gradient of an image represent?

Q 11(b) **[5 Marks]**

What role does gradient play in edge detection?

[End of Question 11]

QUESTION 12 ***[TOTAL MARKS: 10]***

Describe **Bijectivity** and **Size distortion** in the concept of Texture Coordinate Function ϕ. No mathematical proof required.

[End of Question 12]

QUESTION 13 ***[TOTAL MARKS: 10]***

For the given image below:

$A =$

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

Q 13(a) **[5 Marks]**

Compute its approximation pyramid (also known as Gaussian pyramid) using an averaging filter.

Q 13(b) **[5 Marks]**

Compute the Laplacian pyramid using the pixel replication interpolation filter.

[End of Question 13]

[END OF EXAM]