MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

…….YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 518: DIGITAL IMAGE PROCESSING

DATE: **TIME:**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

a) State three needs for applying contrast stretching operation in image processing (3 marks)

b) With the aid of a relevant graphs describe gray level slicing in image enhancement(3 marks)

c) State three aspects of the image that can be enhanced (3 marks)

d) Distinguish between orthogonal and orthonormal functions (4 marks)

e) Test whether the matrix A for is a unitary matrix (4 marks)

$$\boldsymbol{A} = \frac{1}{3}\begin{bmatrix} 1 & -2 & 2 \\ 2 & -1 & -2 \\ 2 & 2 & 1 \end{bmatrix}$$

f) Any arbitrary image $\tilde{u}$ can be represented by a series summation of a set of basis images or unitary matrices as

$$\tilde{\boldsymbol{u}} = \sum_{k=0}^{P-1}\sum_{k=0}^{Q-1} \boldsymbol{v}(\boldsymbol{k},\boldsymbol{l})\boldsymbol{a}_{k,l}(\boldsymbol{m},\boldsymbol{n})$$

i. State the meaning of each of the terms in the expression

ii. Write down the basis image for the Fourier transformation (4 marks)

g) i State any **two** characteristics of each of the following sharpening spatial filters

I. First order derivative

II. Second order derivative

ii From the definition of the laplacian operator in image processing,

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

Derive the Laplacian mask (9 marks)

QUESTION TWO (20 MARKS)

a) i State **two** approaches to image segmentation

ii Distinguish between **first order** and **second order edge** detection methods (4 marks)

b) i Write down the expression of the Gaussian low pass filter

ii Explain the areas of application of the filter in (i) (6 marks)

c) Describe the following thresholding techniques and clearly explain the meaning of Global, Dynamic and Local threshold. (10 marks)

QUESTION THREE (20 MARKS)

a) Describe the Separability property of the two dimensional Fourier transform and explain its significance in Image processing. (4 marks)

b) Explain the

i. Difference between orthogonal and orthonormal signals

ii. Significance of orthonormality and completeness as applied to basis images (4 marks)

c) A 2×2 transform $\boldsymbol{A}$ and image $\boldsymbol{U}$ are given by

$$A = \frac{1}{2}\begin{bmatrix} \sqrt{3} & 1 \\ -1 & \sqrt{3} \end{bmatrix}$$

$$U = \begin{bmatrix} 2 & 3 \\ 1 & 2 \end{bmatrix}$$

Calculate the transformed image V and the basis image (12 marks)

QUESTION FOUR (20 MARKS)

a) Distinguish between image enhancement and image restoration (2 marks)

b) Describe the following methods of estimation of degradation model

i. Observation

ii. Experimentation

(8 marks)

c) The output expression of the Wiener filter is given by

$$\hat{F}(u,v) = \left[\frac{H^*(u,v)S_f(u,v)}{S_f(u,v)|H(u,v)|^2 + S_\eta(u,v)}\right] G(u,v)$$

i. Write down the meaning of each of the terms in the expression.

ii. Explain the circumstances under which the Wiener filter is equal to the inverse filter. Hence write down the expression of the Inverse filter.

iii. Explain the advantage of Wiener filter over an inverse filter (10 marks)

QUESTION FIVE (20 MARKS)

a) Distinguish between histogram equalization and histogram specification. Explain the application of each. (4 marks)

b) i Let r and s represent the pixels in the original image respectively and let $P_r(r)$ and $P_s(s)$ represent the probability density functions of the pixels. Let s=T(r). Where T{.} denotes the transformation function. Let $P_r(r) = \int_0^r P_r(r)dw$. Given that:

$$P_s(s) = P_r(r)\left|\frac{dr}{ds}\right|$$

Obtain $P_s(s)$ and explain why it is an equalization operation.

ii Obtain the discrete formulation of (i) (6 marks)

c) Perform histogram equalization on the following on the following 8×8 image. The grey level distribution of the image is shown in Table 1.

Gray level(r_k)	0	1	2	3	4	5	6	7
No. of pixels(p_k)	8	10	10	2	12	16	9	2

(10 marks)