
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009

November 2008

ZME 338/4 – Physics of Medical Imaging
[Fizik Pengimejan Perubatan]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **SIX** printed pages before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi ENAM muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instruction: Answer **ALL FIVE (5)** questions. Questions 1-3 and 4-5 **must be** answered in two separate Answer Booklet. Students are allowed to answer all questions in Bahasa Malaysia or in English.

Arahan: Jawab **SEMUA LIMA (5)** soalan. Soalan 1-3 dan 4-5 **mestilah** dijawab dalam dua Buku Jawapan. Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

.../2-

Questions 1-3 and 4-5 **must be** answered in two separate Answer Booklet. Each Question 30 minutes.

[Soalan 1-3 dan 4-5 mestilah dijawab dalam dua Buku Jawapan yang berasingan. Setiap soalan 30 minit.]

1. Figure 1 shows the 8-bit digital image in gray levels value of size 256 x 256 pixel. Based on this figure solve the following problems:

[Rajah 1 menunjukkan imej digital 8-bit dalam nilai aras kelabu dengan saiz 256 x 256 pixel. Berdasarkan rajah tersebut selesaikan permasalahan berikut:]

- a) If the image is in the bmp format, estimate the file size of the image.

[Sekiranya imej berkenaan di dalam format bmp, anggarkan saiz fail imej]

(20/100)

- b) Draw the histogram of the image, if the diameter of the circle is 100 pixels and the two identical rectangulars are 40 x 100 pixels each.

[Lakarkan histogram imej berkenaan, jika diameter bulatan ialah 100 pixel dan dua segiempat tepat sama seiras adalah setiap satu 40x100 pixel]

(40/100)

- c) Calculate the mean gray levels value of the image.

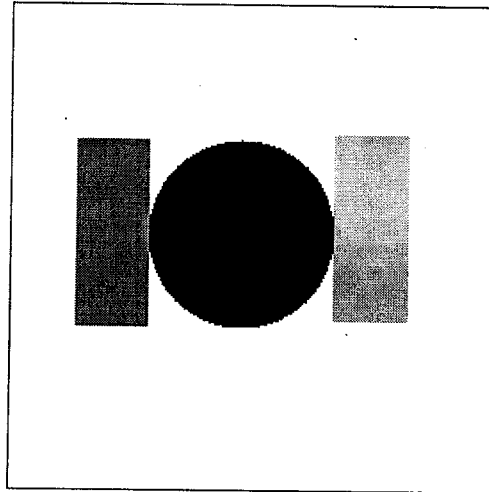
[Kirakan nilai min aras kelabu imej]

(20/100)

...3/-

- d) Find the probability density function of the circle object in the image.
 [Tentukan fungsi ketumpatan kebarangkalian objek bulatan dalam imej berkenaan]

(20/100)



	Gray Levels (Paras kelabu)
	0
	100
	150
	250

Figure 1. A gray levels digital image.
 [Rajah 1. Imej digital aras kelabu]

2. Based on Figure 1 solve the following problems:
 [Berdasarkan Rajah 1 tersebut selesaikan permasalahan berikut:]
- a) Define the convolution discrete function of digital images.
 [Takrifkan fungsi diskret konvolusi bagi imej digital.]

(20/100)

...4/-

- 4 -

- b) If we apply the Laplace operator into the image, draw the expected output image.
[Sekiranya kita kenakan operator Laplace kepada imej, lakarkan jangkaan output imejnya]

(30/100)

- c) Calculate the Laplacian value of the operator in Figure 2 at the centre and the adjacent of the circle with both rectangulars.
[Kirakan nilai Laplasian bagi operator dalam Rajah 2 di pusat dan di titik garis sentuh bulatan dengan kedua segiempat tepat].

$$\begin{array}{ccc} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{array}$$

Figure 2 Laplacian Operator
[Rajah 2 Operator Laplacian]

(30/100)

- d) Give the Fourier transform equation of the image.
[Berikan persamaan transformasi Fourier imej berkenaan]

(20/100)

3. Explain the following term regarding digital image processing.
[Terangkan ungkapan berikut berdasarkan pemprosesan imej digital.]

- a) Define the bit depth for digital images.
[Takrifkan kedalaman bit bagi imej digital.]

(25/100)

- b) Explain the important of Gamma Correction in a digital image display.
[Terangkan kepentingan Pembetulan Gamma dalam pemaparan imej digital.]

(25/100)

...5/-

- 5 -

- c) Explain the relation of JND in Weber's Law.
[Terangkan hubungan JND dalam Hukum Weber.]

(25/100)

- d) Describe the relation of noise with resolution in digital image acquisition system.
[Jelaskan hubungan hingar dengan resolusi dalam sistem pemerolehan imej digital.]

(25/100)

4. (a) (i) Based on Larmor's precession equation, explain briefly the meaning of *resonance* in the technique of MRI
[Berpandukan persamaan liukan Larmor terangkan dengan ringkas maksud resonans di dalam teknik MRI]

- (ii) Explain why the relaxation time T1 for fat is shorter than that of fluid.
[Terangkan kenapa masa santaian T1 bagi lemak adalah lebih pendek berbanding cecair.]

(30/100)

- (b) Regarding T1- and T2-weighted images
[Mengenai imej T1-weighted dan T2-weighted]

- (i) Discuss how the two types of images are obtained with the aid of relevant graphs
[Bincangkan bagaimana kedua-dua imej diperolehi dengan bantuan lakaran graf yang sesuai]

- (ii) Indicate the range of values of TE and TR being used
[Nyatakan julat nilai-nilai TE dan TR yang digunakan]

...6/-

- (iii) Explain why the fluid in T2-weighted image looks hyperintense
[Terangkan kenapa cecair nampak cerah di dalam imej T2-weighted]

(40/100)

- (c) Explain two methods to choose thickness of slice in MRI.
[Terangkan dua cara untuk memilih ketebalan hirisan di dalam MRI]

(30/100)

5. Write short notes on the following topics:
[Tuliskan nota ringkas mengenai]

- (a) Fresnel zone in diagnostic ultrasound imaging
[Zon Fresnel di dalam pengimejan ultraasaun diagnostik]

(30/100)

- (b) The frequency shift in diagnostic Doppler ultrasound
[Peralihan frekuensi di dalam ultraasaun Doppler diagnostik]

(40/100)

- (c) Two aspects of contrast in the computed tomography image
[Dua aspek kontras di dalam imej tomografi berkomputer.]

(30/100)