
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2004/2005

October 2004

ZCT 534/4 - Physics of Diagnostic Radiology
[Fizik Radiologi Diagnosis]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **SIX** pages of printed material before you begin the examination.

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

Instructions: Answer **FIVE** (5) questions only. At least **TWO** questions must be from SECTION A. Students are allowed to answer all questions in Bahasa Malaysia or in English.

Arahan: Jawab **LIMA** (5) soalan sahaja. Sekurang-kurangnya **DUA** soalan mesti dijawab dari BAHAGIAN A. Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

SECTION A

1. (a) Describe photoelectric interactions and Compton scattering.
 [(a) *Perihalkan salingtindakan fotoelektrik dan serakan Compton.*] (30/100)
- (b) Discuss why photoelectric interaction is useful as well as harmful in diagnostic radiology.
 [(b) *Bincangkan kenapa salingtindakan fotoelektrik berguna di samping membahayakan dalam radiologi diagnostik.*] (30/100)
- (c) Explain why Compton scattering must be minimized in the imaging process and outline the steps taken to reduce its effects.
 [(c) *Jelaskan kenapa serakan Compton mesti dikurangkan di dalam proses pengimejan dan gariskan langkah-langkah yang perlu diambil untuk mengurangkan kesannya.*] (40/100)
2. (a) State the three (3) factors that will affect radiographic contrast.
 [(a) *Nyatakan tiga (3) faktor yang akan memberi kesan kepada kontras radiografi.*] (15/100)
- (b) For each factor above, write down the two contributors to each factor and in addition, list down the subsequent reasons why each contributor can finally affect the radiographic contrast.
 [(b) *Bagi setiap faktor di atas, tuliskan dua penyumbang kepada setiap faktor dan sebagai tambahan senaraikan penyebab berkaitan kenapa setiap penyumbang akhirnya akan memberi kesan kepada kontras radiografi.*] (45/100)
- (c) The contrast and visibility of small objects are actually reduced by two (2) factors. Describe these two factors and give the reasons as to why they cause this reduction.
 [(c) *Kontras dan penglihatan objek yang kecil sebenarnya dikurangkan oleh dua (2) faktor. Perihalkan kedua faktor tersebut dan berikan sebab kenapa mereka menyebabkan pengurangan ini.*] (40/100)

3. (a) Describe the three (3) sources of blur in radiographs and explain how they are generated.
 [(a) *Perihalkan tiga (3) sumber keaburan di dalam radiograf dan jelaskan bagaimana ianya dihasilkan.*]
 (60/100)
- (b) (i) Write the formula for the total blur contributed by these three sources.
 [(i) *Tuliskan persamaan keaburan jumlah yang disumbangkan oleh ketiga sumber tersebut.*]
- (ii) If contributions to blur from the three (3) sources are as follows, calculate the value of the total blur
 [(ii) *Jika sumbangan kepada keaburan daripada tiga (3) sumber adalah seperti berikut, hitung nilai keaburan jumlah*]
- source A contributes 0.3 mm
 - *sumber A menyumbang 0.3 mm*
 - source B contributes 0.2 mm
 - *sumber B menyumbang 0.2 mm*
 - source C contributes 0.2 mm
 - *sumber C menyumbang 0.2 mm*
- (20/100)
- (c) Explain what is meant by
 [(c) *Jelaskan apa yang dimaksudkan dengan*]
- (i) Contrast Transfer Function
 [(i) *Fungsi Perpindahan Kontras*]
- (ii) Modulation Transfer Function
 [(ii) *Fungsi Perpindahan Modulasi*]
 (20/100)
4. (a) Detail out the three (3) functions of the intensifying screen.
 [(a) *Perincikan tiga (3) fungsi tabir pengamat.*]
 (30/100)
- (b) With the aid of relevant graphs/diagrams, explain what is meant by
 [(b) *Dengan bantuan graf/rajah berkaitan, jelaskan apa yang dimaksudkan dengan*]
- (i) latitude film
 [(i) *filem latitud*]

- (ii) contrast film
 [(ii) filem kontras]
 (iii) film speed
 [(iii) laju filem]

(45/100)

- (c) Explain the reasons why the breast must be compressed during mammographic examination.

[Jelaskan sebab kenapa payudara perlu dimampat semasa pemeriksaan mamografi.]

(25/100)

SECTION B

5. (a) Detail out five (5) advantages that digital imaging have over analogue imaging.

[(a) Perincikan lima (5) kebaikan pengimejan berdigit ke atas pengimejan analog.]

(50/100)

- (b) With the aid of a diagram, describe the factors that the image intensifier tube have over the intensifying screen in producing a brighter image.

[(b) Dengan bantuan gambarajah, huraikan faktor-faktor tiub pengamat imej menghasilkan imej yang lebih cerah daripada pengamat tabir.]

(30/100)

- (c) State the advantages of fluoroscopic imaging over conventional film radiography.

[(c) Nyatakan kebaikan sistem pengimejan fluoroskopi ke atas radiografi filem lazim.]

(20/100)

6. (a) Discuss six (6) characteristics required for a radioisotope in diagnostic nuclear medicine.

[(a) Bincang enam (6) sifat yang diperlukan untuk radioisotop dalam perubatan nuklear diagnostik.]

(60/100)

- (b) Write down the formulae for the effective half-life of a radioisotope given that the physical half-life is $T_{1/2p}$ and the biological half-life is $T_{1/2b}$.

[(b) Tulis persamaan separuh hayat berkesan suatu radioisotop diberikan separuh hayat fizikal $T_{1/2p}$ dan separuh hayat biologi $T_{1/2b}$.]

(20/100)

- (c) List four (4) advantages of Positron Emission Tomography (PET) over Single Photon Emission Computed Tomography (SPECT).
 [(c) *Senaraikan empat (4) kebaikan Tomografi Pancaran Positron (PET) ke atas Tomografi Berkomputer Pancaran Foton Tunggal (SPECT).]* (20/100)
7. (a) Write short notes on each of the following:
 [(a) *Tulis nota ringkas ke atas setiap satu daripada berikut:]*
- (i) linear attenuation coefficient
 [(i) *pekali pengecilan linear]*
 - (ii) computed tomography number
 [(ii) *nombor tomografi berkomputer]*
 - (iii) window width
 [(iii) *kelebaran tingkap]*
 - (iv) window level
 [(iv) *paras tingkap]*
 - (v) grey scale
 [(v) *skala kelabu]*
- (50/100)
- (b) Given that the computed tomography (CT) number for bone is 334 and the linear attenuation coefficient for water is 0.2046 cm^{-1} , calculate the linear attenuation coefficient for bone at the same energy.
 [(b) *Diberikan nombor komputer tomografi untuk tulang adalah 334 dan pekali pengecilan linear untuk air adalah 0.2046 cm^{-1} , hitung pekali pengecilan linear untuk tulang pada tenaga yang sama.]* (20/100)
- (c) Discuss the differences between third and fourth generation CT scanners.
 [(c) *Bincang perbezaan di antara pengimbas CT generasi ketiga dan keempat.]* (30/100)
8. (a) From the understanding of interactions of ionizing radiation with matter, describe the characteristics required of a phantom.
 [(a) *Daripada kefahaman salingtindakan sinaran mengion dengan jirim, perihalkan sifat-sifat yang diperlukan sesuatu fantom.]* (30/100)

(b) Explain three (3) factors that affect dose to patient in computed tomography imaging and describe the method for these dosimetric tests.

[(b) Jelaskan tiga (3) faktor yang memberi kesan dos ke atas pesakit dalam pengimejan tomografi berkomputer dan perihalkan kaedah untuk ujian-ujian dosimetri ini.]

(35/100)

(c) Briefly discuss image quality in computed tomography and how the quality is monitored.

[(c) Huraikan secara ringkas kualiti imej dalam tomografi berkomputer dan bagaimana kualiti dipantau.]

(35/100)