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]*

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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)

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3. (a) Describe the three (3) sources of blur in radiographs and explain how they are generated.

*[(a) Perihalkan tiga (3) sumber kekaburan di dalam radiograf dan jelaskan bagaimana ianya dihasilan.]*

(60/100)

(b) (i) Write the formula for the total blur contributed by these three sources.

*[(i) Tuliskan persamaan kekaburan 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 kekaburan daripada tiga (3) sumber adalah seperti berikut, hitung nilai kekaburan 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)

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