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UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 2008/2009

November 2008

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

Duration: 3 hours  
*[Masa : 3 jam]*

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

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

**Instruction:** Answer **ANY FIVE (5)** questions only. At least **TWO (2)** questions must be answered from Section A and Section B. Students are allowed to answer all questions in Bahasa Malaysia or in English.

*[Arahan: Jawab **MANA-MANA LIMA (5)** soalan sahaja. Sekurangnyanya **DUA (2)** soalan mestilah dijawab daripada Bahagian A dan Bahagian B. Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

...2/-

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## SECTION A [BAHAGIAN A]

Constants:

Velocity of light	$c = 3 \times 10^8 \text{ m s}^{-1}$
Elementary charge	$e = 1.6 \times 10^{-19} \text{ C}$
Mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$

- 1 (a) Describe the process of production of the X-ray line spectrum. What will happen to the line spectrum if the kVp of the X-ray machine is increased?  
*[Perihalkan proses penghasilan spektrum garis sinar-X. Apakah yang akan berlaku kepada spektrum garis jika kVp mesin sinar-X itu ditingkatkan?]*  
 (35/100)
- (b) Explain the function of the parts of an X-ray tube in relation to:  
*[Jelaskan fungsi bahagian-bahagian tiub sinar-X yang berkaitan dengan:]*
- (i) the focusing of the electron beam;  
*[pemfokusan alur elektron;]*
  - (ii) the cooling of the target;  
*[pendinginan sasaran;]*
  - (iii) the filtration;  
*[penurasan;]*
  - (iv) the limitation of the size of the useful beam.  
*[penghadan saiz alur berguna.]*  
 (40/100)
- (c) State and explain the advantages of using a three-phase compared with a single-phase X-ray generator. Are there any disadvantages?  
*[Nyatakan dan jelaskan kebaikan menggunakan penjana sinar-X tiga fasa berbanding penjana satu fasa. Adakah terdapat sebarang kelemahan?]*  
 (25/100)

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2. (a) Briefly describe the mechanisms by which X-rays interact with tissue to produce secondary electrons. What is the significance of these processes for medical imaging?  
*[Perihalkan secara ringkas mekanisme penghasilan elektron sekunder apabila sinar-X berinteraksi dengan tisu. Apakah kepentingan proses-proses ini bagi pengimejan perubatan?]*  
 (40/100)
- (b) Describe the construction of intensifying screens, and define the term "intensification factor". Briefly discuss the factors to be considered in choosing the type of screen for a given radiographic examination.  
*[Perihalkan binaan layar pengamat, dan takrifkan sebutan "faktor pengamatan". Bincangkan secara ringkas faktor-faktor yang perlu dipertimbangkan ketika memilih jenis layar bagi suatu pemeriksaan radiografi yang diberikan.]*  
 (35/100)
- (c) With the use of a graph, explain what is meant by gamma and latitude of a photographic emulsion, and their relationship to one another.  
*[Dengan berbantuan suatu graf, jelaskan apakah yang dimaksudkan dengan gamma dan latitud suatu emulsi fotograf, dan perhubungan antara mereka.]*  
 (25/100)
3. (a) Describe the construction of an intensifier tube. State its advantages over screen-film in imaging.  
*[Perihalkan binaan suatu tiub pengamat. Nyatakan kelebihanannya berbanding layar-filem dalam pengimejan.]*  
 (50/100)
- (b) What are the physical characteristics of iodine, barium and air which make them useful as contrast agents? What would be the nature of the radiation most suited to a contrast examination employing each of these?  
*[Apakah ciri-ciri fizik yang menjadikan iodin, barium dan udara berguna sebagai agen kontras? Apakah jenis sinaran yang paling sesuai bagi suatu pemeriksaan kontras yang menggunakan setiap bahan ini?]*  
 (50/100)

## SECTION B [BAHAGIAN B]

4. (a) Describe **FOUR** (4) functions that are normally performed with digitized images that are unable to be performed with images recorded on film.  
*[Perihalkan EMPAT (4) fungsi yang biasa dilaksanakan oleh imej berdigit yang tidak dapat dilaksanakan dengan imej yang dirakam oleh filem.]*  
 (40/100)
- (b) Explain the role and reasons why single emulsion film is used in mammography whereas double emulsion is used in conventional radiography.  
*[Jelaskan peranan dan sebab kenapa filem emulsi tunggal digunakan dalam mamografi sementara dua emulsi dalam radiografi konvensional.]*  
 (30/100)
- (c) Discuss the roles of inherent filter and added filter in mammography as compared to chest radiography.  
*[Bincang peranan penuras inheren dan penuras tambahan dalam mamografi dibandingkan dengan radiografi dada.]*  
 (30/100)
5. (a) Beginning by explaining the interactions of ionizing radiation at computed tomography (CT) diagnostic energy level, describe **THREE** (3) characteristics of CT phantom.  
*[Bermula dengan penjelasan saling tindakan sinaran mengion pada tahap tenaga diagnostik tomografi berkomputer (CT), huraikan TIGA (3) sifat yang diperlukan oleh fantom CT.]*  
 (50/100)
- (b) Describe **TEN** (10) CT scanner quality control performance tests.  
*[Huraikan SEPULUH (10) ujian prestasi jaminan kualiti pengimbas CT.]*  
 (50/100)

6. (a)

- (i) Write the equations for transmission and emission projections and define the symbols used

*[Tuliskan persamaan-persamaan untuk unjuran penghantaran dan unjuran pancaran dan takrifkan semua simbol yang digunakan]*

- (ii) By initially defining linear attenuation coefficient, describe how linear attenuation coefficient contributes/affects the formation of images in transmission computed tomography (TCT) and emission computed tomography (ECT)

*[Bermula dengan mendefinisi pekali pengecilan linear, huraikan bagaimana pekali pengecilan linear memberi sumbangan/kesan dalam pembentukan imej tomografi penghantaran berkomputer (TCT) dan tomografi pancaran berkomputer (ECT).]*

(60/100)

- (b) Discuss **FOUR** (4) differences between transmission computed tomography (TCT), single photon emission computed tomography (SPECT) and positron emission tomography (PET).

*[Bincang EMPAT (4) perbezaan di antara tomografi penghantaran berkomputer (TCT), tomografi pancaran berkomputer foton tunggal (SPECT) dan tomografi pancaran positron (PET).]*

(40/100)