

## UNIVERSITI SAINS MALAYSIA

First Semester Examination  
2003/2004 Academic Session

September - October 2003

**ZCT 534/4 - Physics of Diagnostic Radiology**

Time : 3 hours

Please check that the examination paper consists of **EIGHT** printed pages before you commence this examination.

Answer FIVE questions only. At least TWO questions must be from SECTION A. Students are allowed to answer all questions in English OR Bahasa Malaysia OR combinations of both.

**SECTION A**

1. (a) Sketch a cross-section of a basic x-ray tube and label the components. (30/100)
- (b) Describe the events that occur within the tube that lead to x-ray production. (25/100)
- (c) Describe and explain the concept of the two electrical quantities, kV and mA, that are associated with x-ray production. (20/100)
- (d) Discuss at least two functions of the x-ray tube housing. (25/100)
2. (a) State the factors that affect the spectrum of the X-ray. (20/100)
- (b) What are the important interactions between the X-ray photons and tissue for the radiographic energy range? Describe each one of them. (30/100)

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- (c) Discuss the factors that should be evaluated as part of a quality assurance program for x-ray generators. (50/100)
3. (a) Describe why double-emulsion film is normally used and when one might use single-emulsion film. (30/100)
- (b) State the advantages and disadvantages of using intensifying screens of increased thickness. (20/100)
- (c) What are the parameters that can reduce scatter radiation to the film? (20/100)
- (d) Define grid ratio. Discuss the advantages and disadvantages of using high and low grid ratio. (30/100)
4. (a) Draw a cross sectional view and identify the components of an image intensifier tube for a fluoroscopy system. (20/100)
- (b) Describe the operation of an image intensifier tube, including the different image carriers (photons and electrons) that are utilized in the tube. (30/100)
- (c) Briefly describe five functions that can be performed with digital medical images that are not possible with analog images. (50/100)

**SECTION B**

5. (a) Identify and briefly describe the three major phases in the computed tomography (CT) imaging process. (30/100)
- (b) (i) Briefly describe how the physical characteristic of each tissue voxel is measured by the CT imaging process.
- (ii) Show how the CT number for each voxel is calculated from the attenuation characteristics of the tissue. (25/100)
- (c) Compare CT to conventional radiography with respect to: (i) contrast sensitivity, (ii) visibility of detail, and (iii) spatial characteristics (45/100)
6. (a) Describe and illustrate the general concept of the back-projection method of image reconstruction. (40/100)
- (b) Explain what is meant by "filtered" back projection. (20/100)
- (c) Define the followings:
- (i) Computed tomography number and its unit.
- (ii) Window width.
- (iii) Window level. (15/100)
- (d) Sketch and label a graph of grey scale against computed tomography number for the following conditions:
- (i) Window level -50.
- (ii) Window width 500. (25/100)
7. (a) List the 6 characteristics that are required for a radioisotope in an emission computed tomography system. (30/100)
- (b) Taking into account the sources, detectors, collimation procedure and their respective shortcomings, describe the Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) systems. (70/100)

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8. (a) Describe any two of the image quality tests that are frequently carried out in the periodic comprehensive quality assurance test in CT system. (20/100)
- (b) (i) Describe the three main factors that affect the dose to the patient in the CT equipment.
- (ii) Taking into consideration the phantom characteristics, measuring equipment and parameters/indices to be measured, explain how dosimetric tests for the CT scanner can be carried out. (80/100)

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