

UNIVERSITY OF GHANA

B.Sc. BIOMEDICAL ENGINEERING

SECOND SEMESTER EXAMINATIONS: 2012/2013

BMEN 312: MEDICAL IMAGING (3 Credits)

Total Marks: 100.

Time Allocation: 3HRS

This paper is of two sections. Answer all questions in Section A and three (3) questions only from Section B. All questions must be answered in the answer booklet.

This paper should not be removed from the examination hall.

SECTION A

(25 Marks)

Indicate by writing the appropriate alphabet only for the correct answers for questions 1-50

1. The purpose of isolating electrically and acoustically the casing of a probe from the transducer element is to;
A. overcome the acoustic mismatch between the piezoelectric disc and the human tissue
B. prevent large proportion of the incident ultrasound beam to be reflected back
C. minimise acoustic impedance
D. maintain the acoustic sensitivity

2. Coupling materials in ultrasound probes are made from:
I. Silver electrodes II. Epoxy resins III. Water soluble gels
A. I only. B. II only C. III only D. I, II and III

3. Matching layers in ultrasound probes may be made from;
 - I. Epoxy resins II. Perspex III. Silicone rubber
 - A. I and II only B. II and III only C. I and III only D. I, II and III.

4. Which of the following determines the diameter of a transducer element?
 - A. The shape of the transducer
 - B. The shape of the waveform of the operating voltage
 - C. The magnitude of the operating frequency
 - D. The shape of the ultrasound beam

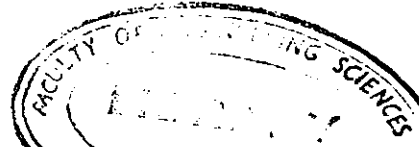
5. Which of the following is the reason for having a backing layer in ultrasound transducers?
 - A. To increase the duration of the ultrasound pulses by damping emissions from the rear surface of the transducer element.
 - B. To reduce the duration of the ultrasound pulses by damping emissions from the front surface of the transducer element.
 - C. To increase the duration of the ultrasound pulses by damping emissions from the front surface of the transducer element.
 - D. To reduce the duration of the ultrasound pulses by damping emissions from the rear surface of the transducer element.

6. The overall activities of an ultrasound imaging unit is coordinated by the:
 - A. Signal manipulation and storage unit B. The pulse generator
 - C. The transducer D. The pulse repetition frequency generator.

7. Which of the following materials is used to provide connection between the pulse generator and the transducer element?
 - A. Tin electrode B. Aluminium electrode C. Silver electrode
 - D. Zinc electrode

8. Which of the following is used to overcome the acoustic mismatch between the piezoelectric disc and human tissue in the design of ultrasound probes?
 - A. The backing layer B. The matching layer C. The backing electrode
 - D. The matching electrode

9. Interference from fringe fields in magnetic resonance scanners can be compensated through;
- A. Relaxation B. Shimming C. Attenuation D. Absorption
10. The three gradient coils in MRI unit are located around;
- A. The patient tube B. Gradient amplifier C. RF transmitter
D. Signal amplifier
11. In MRI system the coils which emit the RF pulse are situated inside the;
- A. Gradient amplifier B. Gradient coils C. Patient tube D. Signal pre-amplifier
12. Which of the following determines the level of image slices in the MRI unit?
- I. the mean frequency of the RF pulse II. The slice selecting gradient.
III. Orientation of magnetic field gradients
- A. I and III only B. II and III only C. I and II only D. I, II and III
13. Eddy current induced in the surrounding metal structures in MRI unit is due to the changes in the current flowing through;
- A. The shim coils B. The RF transmitter coils C. The main magnetic coils
D. The gradient coils
14. Which of the following is the correct sequence of operation in an MRI system?
- I. Computer program triggers the radio pulse synthesizer and gradient amplifiers
II. Imaging pulse sequence initiation
III. Signal generation from the patient detected by the receiver coils
IV. RF and gradient coils energize
V. Signal received is passed to the computer through the preamplifier for storage.
- A. I \Rightarrow II \Rightarrow III \Rightarrow IV \Rightarrow V
B. I \Rightarrow III \Rightarrow II \Rightarrow IV \Rightarrow V
C. II \Rightarrow I \Rightarrow III \Rightarrow IV \Rightarrow V
D. II \Rightarrow I \Rightarrow IV \Rightarrow III \Rightarrow V



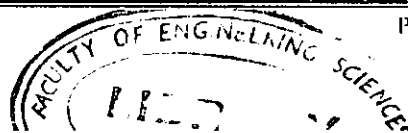
15. Which of the following is/are true about permanent magnets used in MR scanners?
- I. may weigh up to 20 tons
 - II. They are less expensive to operate
 - III. Have a smaller central bore
 - IV. Give low field strength which is unstable
 - V. produces reasonably quality images
- A. I, II, III and IV only B. I, II, IV and V only C. II, III, IV and V only
D. I, II and V only
16. Which of the following sections can be imaged without disturbing the patient or moving mechanical parts?
- I. Sagittal
 - II. Axial
 - III. Coronal
 - IV. Oblique
- A. I, II and III only B. II, III and IV only C. I, II, and IV only
D. I, II, III and IV
17. Which of the following gives the correct overview of magnetic resonance imaging?
- I. a patient is placed in a strong external magnetic field
 - II. The patient emits signal
 - III. A radio wave is turned off
 - IV. A radio wave is sent in
 - V. signal is received and used for the reconstruction of the image
- A. I \Rightarrow II \Rightarrow IV \Rightarrow III \Rightarrow V
B. I \Rightarrow IV \Rightarrow II \Rightarrow III \Rightarrow V
C. I \Rightarrow IV \Rightarrow II \Rightarrow V \Rightarrow IV
D. I \Rightarrow IV \Rightarrow III \Rightarrow II \Rightarrow V
18. In nuclear magnetic resonance, relaxation time T_2 gives information about
- A. The physical state of the subject
 - B. the nature of the biochemical surroundings
 - C. the nuclear state of the subject
 - D. the state of stability of the subject

19. The couch of magnetic resonance scanners are made of
- A. Ferrous materials B. Non-ferrous materials
C. Semi-conducting materials D. Biomaterials
20. Superconducting coils are cooled by immersion in liquid helium which evaporates at
- A. 4°C B. 4 K C. 77 K D. 77°C
21. Which of the following magnetic resonance magnets can produce a stable field?
- I. Resistive II. Permanent III. Superconducting
- A. I and II only B. II and III only C. I and III only D. I, II and III
22. The cavities in coils of superconducting scanners are meant to restrict heat transfer by;
- A. Conduction B. Convection C. Radiation
D. Conduction and Radiation
23. The target material for a mammographic unit is usually made from
- A. Tungsten and Rhodium B. Molybdenum and Rhodium
C. Molybdenum and Tungsten D. Tungsten and Palladium
24. What is the effect of low kV value in mammographic equipment in the X-ray beam?
- I. Long exposure time II. High risk of image unsharpness
III. High contrast. IV. Low beam intensity
- A. I and II only B. I, III and IV only C. I, II and III only
D. I, II and IV only
25. At Kilovoltages greater than 25 kV, mammographic units may have filters made from;
- I. Rhodium II. Molybdenum III. Palladium
- A. I and II only B. I and III only C. II and III only
D. I, II and III
26. The suitable material for filters in mammographic unit at kV's of 20-25 KV is;
- A. Molybdenum B. Rhodium C. Palladium
D. Aluminium



27. Space charge compensation in mammographic units is achieved by;
- A. Lowering the filament temperature B. Boosting the filament current
C. Boosting the filament temperature D. Narrowing the gap between the electrodes
28. The capability of the system to make visible small details or calcifications down to about 0.1 mm is known as;
- A. Sharpness B. Noise C. Contrast D. Spatial resolution
29. The surface of breast support plate may be made of;
- A. Carbon fiber B. Glass fiber C. Lead D. Aluminum sheet
30. What is the recommended focus-to-film distance and focal spot size in mammographic units?
- A. 45-60 mm and 0.4- 0.6 mm B. 45-60 cm and 0.4-0.6 cm
C. 45-60 cm and 4- 6 cm D. 45-60 cm and 0.4-0.6 mm.
31. What is the KV range for mammographic x-ray generators?
- A. 30-45kV B. 50-80kV C. 20- 80kV D. 20-45 kV
32. The effect of low kV value in mammographic units is offset by using;
- A. High potential generator B. Six-pulse generator
C. Two-pulse generator. D. Constant potential generator
33. Automatic exposure timing is an essential feature of mammographic equipment because of;
- A. Durability and efficiency B. Efficiency and portability
C. Variation of breast size and opacity D. High exposure rate
34. The variation in image density gradients created by the shape of the breast may be lessened by;
- A. the use of filters B. Beam collimation C. the use of gentle compression
D. Beam alignment

35. Which of the following material is used for the window of the x-ray tube of mammographic units?
- A. Glass with a maximum thickness of 1 mm
 - B. Beryllium with a maximum thickness of 1 mm
 - C. Aluminium with a maximum thickness of 1 mm
 - D. Molybdenum with a maximum thickness of 1 mm
36. Which of the following are incorporated on mammographic equipment as a means of patient reassurance?
- I. Handles are provided for the patient to grasp for steadiness during the procedure
 - II. The manoeuvrability of the equipment can allow the patient to sit, stand or lie down, according to need.
 - III. The control panel is commonly separated from the patient by a full-length lead glass protection screen.
 - IV. The surface of breast support plate is warm to touch
- A. I, II and IV only B. II, III, and IV only C. I, II and III only D. I, II, III and IV
37. The tube head for a simple dental unit in most long focus-to-film distance contains
- A. A rotating anode tube insert, filament transformer, high tension transformer and expansion bellow
 - B. A stationary anode tube insert, high tension transformer, tube filament transformer and expansion bellow
 - C. A grid anode tube insert, filament transformer, high tension source and expansion bellow
 - D. A rotating anode tube insert, nasal positioner, high tension transformer and AEC
38. Dental radiographic equipment may deliver entrance doses between
- A. 0.5 and 150 mGy B. 5 and 50 mGy C. 5.0 and 150 mGy D. 0.5 and 50 mGy
39. A Simple Dental unit is made up of the following components:
- A. Tube head, Nasal positioner, control unit B. Tube support, Control unit, tube insert
 - C. Tube head, Tube support, Control unit D. Tube support, control unit and moderator



40. What type of motion is employed in an Orthopantomography dental equipment?
- A. Synchronized oscillatory B. Synchronized harmonic
C. Synchronized rotary D. Synchronized rectilinear
41. What are the functions of the cone at the tube port of a dental tube head?
- I To collimate and centre the X-ray beam.
II To guides the radiographer to use the correct focus-film distance.
III. To guide the flow of thermionic electrons in the tube.
- A. I only B. I and III only C. I and II only D. I, II, and III
42. How is the dental tube-head protected against electrical and primary radiation hazard?
- I. The tube head is insulated internally with oil
II. The tube housing is lead lined
III Tube head is earthed via both its supply cable and its mounting.
- A. I and:II only B. I and III only C. II and III only D. I, II and III
43. The dental tube head is joined to the tube support by means of
- A. Bearings B. Shaft C. Gimbal D. Split rings
44. The filters used in Cephalostat units are made of;
- A. Tungsten B. Duralumin C. Aluminium D. Palladium
45. The casing of a dental tube head is made up of;
- A. Molybdenum lined with lead B. Aluminium lined with lead
C. Aluminium alloy lined with lead D. Molybdenum alloy lined with lead
46. Simple dental unit has low power of X-ray production which implies
- I. Relatively high rate of heat production
II. Relatively low rate of heat production
III. Safe use of stationary anode X-ray tube
- A. I and II only B. I and III only C. II and III only D. I, II and III

47. Which of the following is used to ensure the use of a much longer focus- to- film distance?

- A. Conical plastic cone
- B. Conical metallic cone
- C. Conventional metallic cone
- D. Lead alloy

48. What type of X-ray tube is in Craniostat Unit?

- A. Low power rotating anode type
- B. Medium power rotating anode type
- C. High power rotating anode type
- D. High power stationary anode type

49. Patients are located in orthodontic examination using a Cephalostat Unit by;

- I. earplugs
 - II. suspension
 - III. nasal positioner
- A. I and II only
 - B. II and III only
 - C. I and III only
 - D. I, II, and III

50. The total tube's inherent filtration in a simple dental unit is

- A. 10-20mm Al
- B. 1- 2 cm Al
- C. 1-2mm Al
- D. 3-5mm Al

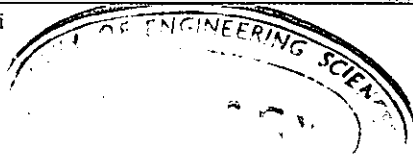
SECTION B

(75 Marks)

Answer only three questions from this section

Question 1

- (a) Draw a block diagram demonstrating the core modules in ultrasound imaging equipment and state the main functions of each module. **(10 marks)**
- (b) Describe the mode of operation of a pulse-echo ultrasound imaging. **(6 marks)**
- (c) Use piezoelectricity to explain the function of an ultrasound transducer **(3 marks)**
- (d) State **three** similarities and **three** differences between ultrasound imaging and X-ray imaging. **(6 marks)**



Question 2

- (a) With the aid of a well-labelled block diagram, describe the mode of operation of a Magnetic Resonance Imaging System. (10 marks)
- (b) State five (5) installation requirements of a Magnetic Resonance Scanner. (5 marks)
- (c) What are the **causes** and **effects** of leakage of cryogenic gas in a Magnetic Resonance facility? How could leakage of the gas be detected? (5 marks)
- (d) Explain nuclear magnetism. What factors determine it? (5 marks)

Question 3

- (a) Write short notes on the design of the following components in mammographic equipment;
- The X-ray tube insert
 - The breast support plate / table
 - The breast compression paddle
- (8 marks)
- (b) Mention three important principles which are significant in the mammographic techniques. (3 marks)
- (c) Describe briefly how mammographic equipment should be designed to meet each of the three principles required in (b) above. (3 marks)
- (d) Briefly explain why molybdenum target material is used with molybdenum filter in mammographic equipment instead of Aluminum filter. (3 marks)
- (e) How is mammographic equipment designed to ensure radiation protection and enhance image quality? (3 marks)
- (f) What is the effect of the use of low beam quality or kVp in mammographic unit? Explain how this effect can be offset. (5 marks)

Question 4

- (a) With the aid of a well-labelled diagram describe the structure and principle of operation of Orthopantomographic equipment. (8 marks)
- (b) Give four merits each for a Cephalostat and an Orthopantomographic unit over a simple dental unit. (8 marks)
- (c) List five (5) features on an Orthopantomography unit that enhances patient safety and promotes image quality. (5 marks)
- (f) Mention two (2) types of cone attachment on the mounting plate surrounding the tube port of the simple dental unit. What are their functions? (4 marks)

Question 5

- (a) Explain the occurrence of the following phenomena in Magnetic Resonance Imaging
- Longitudinal magnetisation
 - Transversal magnetisation
 - Spin-lattice-relaxation/ Longitudinal relaxation
 - Spin-spin-relaxation/transversal relaxation
- (16 marks)
- (b) What is the essential requirement for the diagnostic reliability of mammographic images? How can this requirement be achieved? (4 marks)
- (c) What is the basis of accuracy and reliability in Cephalometric unit? (2 marks)
- (d) State three basic functions of ultrasound imaging equipment? (3 marks)

