

CHUKA



UNIVERSITY

## UNIVERSITY EXAMINATIONS

## EXAMINATION FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE IN PHYSICS

## MPHY 818: RADIOLOGY (IONISING RADIATION)

STREAMS: MPHY

TIME: 2 HOURS

DAY/DATE: MONDAY 08/04/2024

2.30 P.M – 5.30 P.M.

**INSTRUCTIONS:**

- Answer question ANY FOUR questions

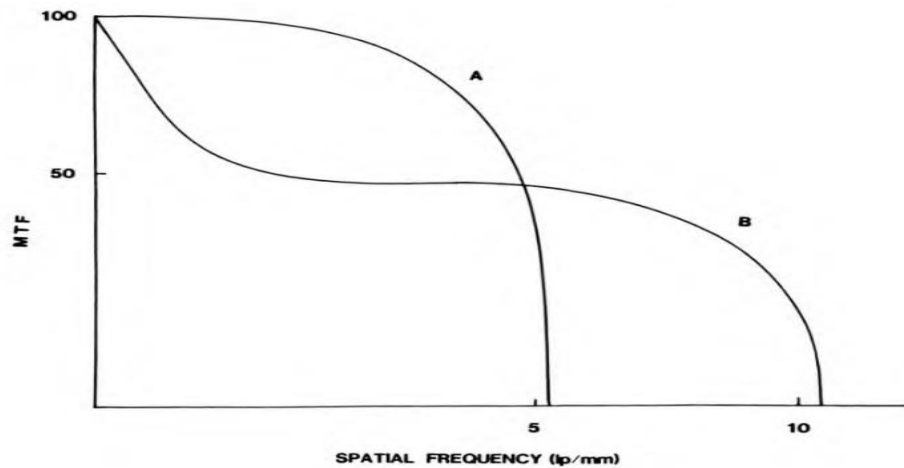
**QUESTION ONE (15 MARKS)**

- Describe the process of X-ray production. (3 marks)
- Explain why filters are added to an x-ray beam (2 marks)
- Define image quality and describe contrast and resolution in relation to image quality
- Describe four major sources of unsharpness in radiography (2 marks)
- What is the size of the penumbra blur in a radiograph taken with a 2 mm focal spot if the SID is 40" (102 cm) and the object is 10" (25 cm) from the film? (3 marks)
- What is the blurring of a cardiac image if the heart wall moves with a velocity of 18 cm/s and the exposure time is 0.15 seconds? (2 marks)
- Define the following terms in relation to X-ray imaging (i) Detector Blur (ii) Modulation Transfer Function (iii) Receiver operating characteristic (ROC) Tests (3 marks)

**QUESTION TWO (15 MARKS)**

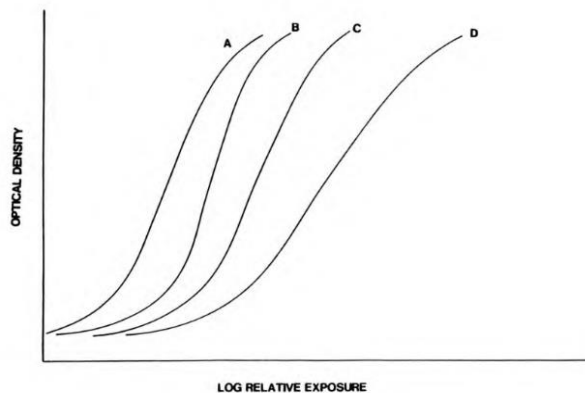
- Explain how X-rays produce a change in the film emulsion, use a sketch (3 marks)
- Plot a typical characteristic curve of film optical density as a function of log relative exposure. (2 marks)
- What is film speed? A film screen combination required 8 mR to produce an optical density of 1 above base fog. What is the speed of this combination? (2 marks)

- d) In Figure 1. which system would be better for imaging large low contrast objects? Which system would be better for imaging small objects? Use A or B (2 marks)



**Figure 1.**

- e) A film of optical density 1.8 is placed in front of a film of optical density 1.2. The combination has an optical density will be (2 marks)
- f) Two portions of a film whose T is 2.1 differ in exposure by a factor of 5. If the lighter portion has a density of 0.8, what is the density of the darker portion? (2 marks)
- g) Which film has the widest latitude?, (ii) which film has the highest gamma?, (iii) Which film is fastest?, (iv) which film is the slowest? Choose A, B, C or D (2 marks)



**Figure 2.**

### QUESTION THREE (15 MARKS)

- a) Describe Scotopic vision and photopic vision (2marks)
- b) List the steps in image formation with an image intensifier (2 marks)
- c) A 15 cm diameter (in p u t) image intensifier tube with an output diameter of 2.56 cm has a flux gain of 46. What is the brightness gain of this tube? (3 marks)

- d) Explain the resolution of Fluoroscopic images recorded either on film or video tape. (3 marks)
- e) What is the exposure rate to the patient in R /m in at a frame rate of 20 f/s if the entrance exposure is 6m R /frame? (3 marks)
- f) Describe High exposure Effectsof radiation (2 marks)

#### QUESTION FOUR (15 MARKS)

- a) What is the pixel size in mm and th e resolution in lp/m m if a 256 x 256 matrix used to image a 32 cm diameter image intensifier? (3 marks)
- b) Describe a schematic view of digital subtraction angiography (3 marks)
- c) Calculate the signal and statistical noise in a Digital Subtraction Angiography (DSA) image if the mask image has an average o f 1600 photons per pixel per exposure and 1350 photons per pixel in the contrast image. (3 marks)
- d) What is the relative uncertainty in the fourth gray level (midrange) in a system that has 16 shades o f gray (16 gray levels) if the brightest level requires 6000 counts per pixel? (2 marks)
- e) What is the SNR o f an object with 2240 counts per pixel surrounded by pixels w ith 2000 counts? (2 marks)
- f) Define Genetically Significant Dose(2 marks)

#### QUESTION FIVE (15 MARKS)

- a) Describe the different CT Artifacts (4 marks)
  - b) In CT scanning if all other factors remain the same how is spatial resolution affected by the following changes: (i) Increased matrix size, (ii) Reduced scan time, (iii) Increased scan diameter, (iv) Increased pixel size (v)Increased slice thickness, (vi) Increased patient thickness State whether it Increases, Decreases or remains the same (3 marks)
  - c) Arrange in order of increasing CT number 1. Air, 2. Bone, 3. Fat, 4. Muscle (2 marks)
  - d) Describe mammography imaging technique and conventional tomography (4 marks)
  - e) How will these changes affect the thickness o f the cut in conventional tomography if all other factors remain the same?(i) Increase tube angle, (ii) Use high speed screens, (iii) Decrease linear motion, (iv) Increase circumference of the circular motion. State whether it will increase, decrease or remain the same. (2 marks)
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