ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2019
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR RADIOLOGY AND IMAGING SCIENCE TECHNOLOGY

Date	: October 13, 2019
Total Marks	: 100
Writing Time	: 150 minutes (2.5 hours)
Reading Time	: 15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is being provided to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
   - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
     Part II - 4 Short Answer Questions

     All questions under SECTION A are COMPULSORY.
   - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part in a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You are required to hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **7 printed pages**, including this instruction page.

GOOD LUCK

SECTION A

PART I: Multiple Choice Questions (30 marks)

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. The intensity of the X-ray beam
   a) is directly proportional to the kvp.
   b) depends on the atomic number of the target.
   c) is increased by filtration.
   d) is inversely proportional to the current.

2. X-rays are produced by
   a) heating a tungsten filament.
   b) moving orbital electrons from a " L "shell.
   c) heating a molybdenum anode.
   d) bombarding a target with electrons.

3. Regarding radiation protection in the X-ray room:
   a) Providing exposure to primary radiation is avoided, the major source for the staff will be scattered radiation.
   b) If distance from the source of radiation doubles, then radiation exposure is reduced by a factor of 2.
   c) Lead aprons are useless for radiation protection.
   d) Radiation protection in a fluoroscopy room can be minimal as the dose exposure is less.

4. Which of the following does not affect the quality of the primary X-ray beam?
   a) Tube kilo-voltage
   b) Tube current
   c) Anode target material
   d) Tube fixed filtration.

5. The linear attenuation coefficient (LAC) of a material
   a) relates to the probability that a photon interaction will occur in the material.
   b) has unit in centimeters.
   c) does not depend on the atomic number & density.
   d) is equal to the product of the individual interaction coefficients.

6. The probability of a photoelectric reaction
   a) is low for low energy photons in soft tissue.
   b) has no effect with use of contrast media.
   c) is directly proportional to the material density.
   d) is independent of the atomic number.

7. Regarding the attenuation of an X-ray beam, which statement is FALSE?
   a) Is higher for a polyenergetic beam than monoenergetic beam.
   b) Is less for a broad beam.
   c) Is measured using a narrow collimated beam.
   d) Is due to photoelectric reaction only.

8. Filtration in X-ray
   a) increases the contrast.
   b) increases the effective energy.
   c) decreases MAS.
   d) increases patient dose.

9. Exposure is measured as
   a) Coulombs per kilogram.
   b) the photon reflux.
   c) Sieverts.
   d) the energy deposited in tissue.

10. Increase in the following factors contribute to the increase in scatter radiation, EXCEPT
    a) Tube current
    b) Field size
    c) Anatomic part thickness
    d) Filtration

11. Regarding Image intensifiers:
    a) The input fluorescent phosphor is made of calcium tungstate.
    b) The photocathode is at the output screen.
    c) The electrostatic focusing lens focus the electron beam as it flows from photocathode to output phosphor.
    d) Magnification gain is one of the artefacts seen in image intensifier tube.

12. The digital subtraction angiography (DSA) is
    a) continued luminescence after X-ray stimulation has stopped.
    b) the subtraction from subsequent frames following contrast administration to generate a subtracted image showing only the contrast filled vessels.
    c) the increase in image brightness that results from reduction in image size from the input phosphor to the output phosphor.
    d) performed even with simple X-ray machine.

13. Regarding radiation & pregnancy:
    a) Ten-day rule applies to the first 10 days after the menstruation has ceased.
    b) Stochastic effects have no impact on the embryo.
    c) Early pregnancy is safe for x-ray.
    d) For a fetus exposed to high dose procedure there is about a doubling of the natural cancer risk.

14. When discussing radiation damage to the cell, which statement is FALSE?
    a) Mammalian cells have a linear survival response.
    b) Indirect damage is caused by free radical.
    c) Water is major source of free radical.
    d) Direct & indirect damage events can form chain events.

15. The radiation dose for an occupational employee within one year should not exceed
    a) 30mSv.
    b) 40mSv.
    c) 20mSv.
    d) 10mSv.

16. The patient dose is reduced by
    a) usage of grids.
    b) using a compression paddle in mammography.
    c) usage of low voltages.
    d) a short focus to skin distance.

17. Standard protective body aprons
    a) should be about 0.25 mm lead equivalent.
    b) are effective against gamma radiation.
    c) are used to protect the wearer from primary beam.
    d) are not used in children.

18. Regarding electromagnetic radiation, all EM waves have the same
    a) frequency.
    b) amplitude.
    c) velocity.
    d) wavelength.

19. All of the following are examples of EM waves, EXCEPT
    a) Radio waves
    b) Gamma rays
    c) Microwaves
    d) Ultrasound waves

20. Regarding the ultrasound:
    a) The frequency of a sound wave is directly related to its wavelength.
    b) The thicker the piezoelectric crystal the greater the resonance frequency.
    c) The thyroid gland is best imaged with a linear transducer.
    d) Ultrasound is best imaging modality for lung pathology.

21. In diagnostic ultrasound:
    a) The frequency of the beam is between 15,000 & 20,000hz.
    b) Refraction is the change of beam direction when passing between different media.
    c) The doppler effect is used for bone mineral measurement.
    d) The superficial transducer has low frequency.

22. Following are interactions between ultrasound & matter, EXCEPT
    a) Reflection
    b) Absorption
    c) Acoustic Impedance
    d) Refraction.

23. Spiral CT depends on all the following, EXCEPT
    a) Slip ring technology
    b) Narrow beam collimation
    c) Pulsed high-frequency power supply
    d) Fixed gantry system

24. Which statement regarding CT artifacts is WRONG?
    a) Detector malfunction gives beam hardening artifact.
    b) Cardiac motion produces streak artifacts.
    c) Dental amalgam gives star artifacts.
    d) Geometrical artifacts are due to diverging beam, CT slices are narrower at the center than at the edge.

25. Which of the following regarding Computed Tomography (CT) is TRUE?
    a) Increasing scanning time reduces patient dose.
    b) CT number is zero for fat.
    c) Barium contrast can be used for obese patients.
    d) Reducing slice thickness increases spatial resolution.

26. Multi-slice CT scanner:
    a) Takes longer scanning time than single slice scanners.
    b) Always uses contrast.
    c) Gives a higher spatial resolution then the single slice scanners.
    d) Lesser anatomic coverage.

27. The CT X-ray generator supply
    a) is commonly single-phase full wave rectified.
    b) have special long leads.
    c) can be sited within the gantry with high frequency circuit.
    d) requires single-phase main supply.

28. Which following statement regarding MRI is INCORRECT?
    a) T1W image show water as dark signal.
    b) T2W image show CSF as bright signal.
    c) Fat signal is bright in both T1 & T2 images.
    d) STIR images are used to suppress the fluid signal.

29. The MRI:
    a) Can demonstrate function.
    b) The spatial resolution is as good as fluoroscopy.
    c) Can suffer from thickness effect.
    d) Show bone as hyper signal.

30. With regard to MRI artifact:
    a) Chemical artifacts can be reduced by using the smallest possible field of view.
    b) Motion has no effect.
    c) Ferromagnetic objects only alter t1 decay characteristics so only t1w images affected.
    d) Aliasing artifact show the structures peripheral to the field of view wrapping up around the image and can be seen on the opposite edge.

PART II – Short Answer Questions (20 marks)

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks.

1. What do you mean by the term 'justification" in radiation protection? What are the hazards of radiation? (2+3 marks)

2. List contrast radiographic studies of the Genito-urinary system. Write a short note on Micturating Cystourtherogram (MCU). (2+3 marks)

3. Briefly describe the ultrasound Transducer. What are the artifacts of USG? (3+2 marks)

4. What are the principles used in CT & MRI? Write a short note on multidetector CT (MDCT). (2+3 marks)

SECTION B: Case Study (50 marks)

Choose either CASE I or CASE II from this section. Each case study carries 50 marks. Mark for each sub-question is indicated in the brackets.

CASE I

A 65 years old female was brought to the Emergency Department with history of acute altered sensorium, slurring of speech and weakness of the right half of body since the morning. The Emergency Physician after examining the patient had asked for various radio imaging. As the technologist attending the case on call, answer the following questions in this case scenario:

1. What is your provisional diagnosis? Describe how you would perform the MRI brain of the patient (2+8 marks)

2. Mention the basic MRI sequences. Explain the salient features of each sequence that you have mentioned (5+10 marks)

3. Write short note on magnetic resonance angiography (MRA). (7 marks)

4. How will you perform the dynamic MRI of pituitary gland? (10 marks)

5. What is the role of CT in this case? Write the principle of CT scan. (3+5 marks)

CASE II

An Indian labourer was brought to the Emergency Department with history of fall from the height while working at the construction site. He is confused and gave history of loss of consciousness, vomiting and bleeding from nose. On examination there is rapid pulse rate, increased respiration, few cut wounds and tenderness at head, chest & abdomen. The ER physician says he is case of poly trauma. You are the technologist attending the case. In this context, answer the following questions:

1. What are the radiological imaging modalities required for this patient? What are your preliminary findings? (4+3 marks)
2. What is the role of abdominal X-ray on this patient? Describe the techniques & positioning in AXR. (2+5 marks)
3. What do you understand by FAST? What are your probable findings? (3+2 marks)
4. Describe how you would perform the CT scan of head. What are the disadvantages of CT? (7+5 marks)
5. Write the CT protocol for abdomen. What are the contraindications of contrast in CT? (8+3 marks)
6. Write about the basic sequences in MRI. What are the common artifacts in MRI? (4+4 marks)

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