127

THE OPEN UNIVERSITY OF SRI LANKA
B .Sc DEGREE PROGRAMME – LEVEL –05
FINAL EXAMINATION-2008/2009
MEDICAL PHYSICS -PHU 3158 /PHE 5158
DURATION: TWO AND A HALF (2½) HOURS.

DATE: 31st December 2009 **TIME: 9.30 A.M – 12.00 Noon**

ANSWER ANY FOUR (04) QUESTIONS ONLY

Speed of light in a vacuum (c)=3.00 x 10^8 ms^{-1}

1. (a) (i) Discuss the features of optical fibres in details.

(ii) Explain the difference between coherent and incoherent bundles of fibres.

(iii) State the advantages of using endoscopes to examine the inside of the body (as a part of keyhole surgery). Describe the key parts of an endoscopes.

(iv) A pulse of white light is sent straight down a fibre optic cable 1 km long. If refractive index for blue light is 1.639 and for red light is 1.621, what time interval will there be between the two components when they reach the far end?

(b) (i) Briefly explain the term of Macrotelemetry.

(ii) What do you understand by Digital image communication?

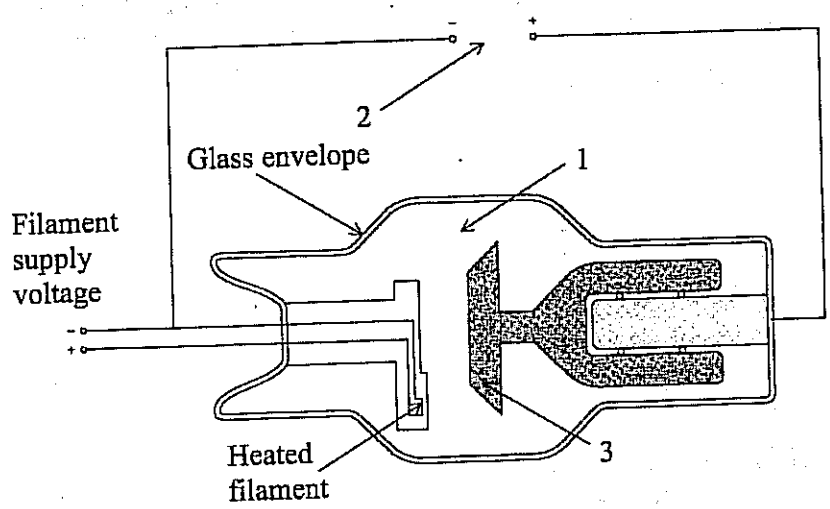
2. (a) Defining the symbols you use derive expressions for the Doppler shift in frequency from a plane interface moving,

(i) directly towards the source of waves
(ii) directly away from the source of waves

(b) What are the implications if a Doppler system registers only the magnitude of the Doppler shift? State two specific applications of Doppler effect in medical diagnosis.

(c) Ultrasound of frequency 5 MHz is reflected from a structure in the heart and found to be Doppler shifted by 400Hz. If the speed of ultrasound in the body is 1.8 kms^{-1}, estimate the speed of the moving structure.

3. (i) The diagram below shows a rotating anode X-ray tube.



Name and explain the function of the numbered parts of the X-ray tube. In X-ray diagnosis the absorption of keV X-rays is highly dependent on Z.

(a) What is represented by Z?

(b) Explain the relevance of Z in the production of radiographic images.

(c) An X-ray tube operating at 65 kV has a tube current of 0.12 A. It produces X-rays with an efficiency of 0.8 %.

(i) Calculate the rate of production of heat at the anode.

(ii) What feature of the X-ray tube helps dissipate this energy?

(iii) Would the X-rays produced by this tube be more suitable for diagnosis or therapy? Justify your answer.

(d) On an X-ray radiograph, bones show up as bright areas and air spaces such as the lungs produce dark regions. Explain why.

(ii) What are the advantages of positron emission tomography (PET) over single photon emission tomography (SPECT) as a tool for investigating disease process? Why is PET not used more widely?

4. (a) What do the initials NMR stand for?

Explain the role of the above three terms.

(b) What is the purpose of the magnetic gradient fields employed in Magnetic Resonance Imaging (MRI)?

How many are required and why?

(c) What parameters are displayed on an MRI image?

(d) How safe is MRI?

(e) State four differences between MRI and Computed Tomography (CT) scan.

(f) For a particular brain scan, a slice thickness of 2.5 mm is specified. A slice gradient field of 0.015 Tm^{-1} is used. Estimate the necessary bandwidth (frequency range) necessary in the applied radio frequency (rf) pulse.

(Assume $\frac{\gamma}{2\pi}$ is 42.6 MHz T^{-1} where γ is the gyromagnetic ratio)

5. (a) Explain why the physical half-life (T_P) of a radionuclide in a biological system differs from its effective half-life (T_E) and state what is meant by the biological half-life(T_B). Write down an equation which relates these three quantities.

(i) A radioactive sample has an initial activity of 6 MBq and a half-life of 25 s. Calculate its activity after 2 minutes.

(ii) If 11% of ^{99m}Tc-labeled diisopropylimindodiacetic acid (DISIDA) is eliminated via renal excretion, 35% by perspiration in 5 hr from the human body, ^{99m}Tc has a physical half-life of 6 hr, estimate the effective half-life of the radiopharmaceutical.

(b) (i) How are we exposed to radiation?

(iii) What is the difference between long-term versus short-term radiation exposure?

(iii) What is a dosimeter? Is it more appropriate to use a dosimeter to measure personal, actual exposures, than estimating exposures based on mathematical projections?

(iv) What is the potential for cumulative effects from multiple radiation exposures?

6. (a) What is cancer?

(b) What are the common signs and symptoms of cancer?

(c) How is cancer treated?

(d) How does radiation kill cancer cells?

(e) Explain what is meant by external beam radiotherapy (EBT) treatment plan and outline the procedures adopted in order to achieve an acceptable one. Your answer should contain reference to the following terms:

*	Target volume	*	Isodose curve
*	Critical organ	*	Fractionation scheme
*	Multiple or Rotational beams	*	Wedge
*	Compensator and	*	Simulator

(f) Why is radiation treatments divided into small daily doses?

(g) What are the side effects from radiation therapy (RT)?

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