

THE OPEN UNIVERSITY OF SRILANKA

PHU 3158

MEDICAL PHYSICS

Home Assignment-2010

Answer all questions

Submit on or before 15th of March 2010

01. (a) What does LASER stand for?
(b) Give five uses of lasers in medicine, indicating the properties which make them suitable.
(c) State the different type of lasers and explain briefly the principles of action of one of them.
(d) The spot size of the He-Ne laser beam is 0.4 mm and wave length of the beam is 633nm. If the cavity of the laser is confocal type find the length of the laser cavity.
(e) What should you do, when you accidentally allowed light from the He – Ne laser in to your eye and what would you observe as a result of that exposure?
- 02 (a) Discuss briefly the scanning methods that uses ultra sound (Illustrate with figures)
(b) Give the applications / uses of each scanning methods in medicine.
(c) Find Doppler Shift, when the blood passes thorough the vessels with velocity v and the transmitter frequency f .
(d) Deduce expression for Doppler Shift when the transmitter makes an angle θ with the blood vessel.
(e) In a blood flow investigation, a source of 5 MHz Ultra sound directed at an angle of 60° produce a Doppler Shift of 150 Hz. Assume that the speed of the wave is 1.5 kms^{-1} . What is the speed of the blood?
- 03 (a) Describe the emission of X- rays with diagrams and state the properties of X- rays.
(b) What are the factors affecting the X- ray beam.
(c) Define Half value thickness and Tenth value thickness of a shielding material for a given radio isotope for narrow and broad beam conditions.
(d) A Cobalt -60 source shielded by 25 mm thick steel housing gives an exposure rate of $50 \text{ mGyh}^{-1} \text{ GBq}^{-1}$ at 2 m from the source position. If $^{60} \text{Co}$ is replaced by $^{192} \text{Ir}$ the exposure rate remains same at the same point.
Find the activity if each source

Source	Steel (TVT) cm	Exposure rate constant σ ($\text{mGyh}^{-1} \text{ GBq}^{-1} \text{ m}^2$)
$^{192} \text{Ir}$	4	0.114
$^{60} \text{Co}$	6.6	0.31

04. (a) Briefly explain the principle of fibre optics.
 (b) Differentiate Coherent and Incoherent Bundles in fibre optics.
 (c) Define the term Numerical aperture of a fibre
 (d) A particular fibre has a refractive index of 1.51 and is clad in a material of refractive index 1.40. Find the Numerical aperture of a fibre.
 (e) What are the two main types of endoscopes?
 (f) Explain the function of an endoscope with the aid of a diagram.
05. (a) Describe the terms precession, T_1 Process and T_2 Processes in MRI.
 (b) Briefly describe the imaging principle of MRI scan.
 (c) What do you understand by Larmor Frequency?
 (d) Discuss the peripherals of an MRI system with the aid of a diagram and the purpose of each of them
 (e) A patient of 1.55 m is placed in a uniform magnetic field of flux density 1.4 T directed from his feet to his head. A gradient field of 0.014 Tm^{-1} is applied, again from his feet to his head. If assume gyro magnetic ratio γ is 267.8 MHzT^{-1} , estimate the frequency of the transmitted Radio frequency pulse required to produce proton resonance in a slice through his abdomen, 0.8 m from his feet.
06. (a) What are the points to be considered when selecting the radio nuclide label?
 (b) Define biological physical and effective half- life.
 (c) In Thyroid if $T_{1/2 \text{ BIO}} = 15$ days and $T_{1/2 \text{ PHY}} = 8$ days. What is the effective Half- life?
 (d) Give the advantages and disadvantages of a solid - state semiconductor over a scintillation detector
 (e) Briefly explain the function of gamma camera.
07. (a) What are the radiation protection rules?
 (b) What do you understand by controlled area and supervised area?
 (c) List the cancer warning signals.
 (d) What are the main aims of External Beam Treatment Planning?
 (e) What are the steps to be followed when planning for treatment in Radiotherapy?
08. (a) Why Co-60 sources are preferred to be used in linear accelerators?
 (b) If electrons are accelerated in a LINAC through a series of drift tubes, calculate the voltage across the tube.
 (c) Define equivalent dose.
 (d) Explain why Sievert (Sv) is more suitable unit in health physics than Gray
 (e) State Inverse Square Law.

(f) A Cobalt -60 source gives a dose rate at 1 m from it of $80 \mu\text{Sv h}^{-1}$

(i) At what distance from the source is the dose rate $25 \mu\text{Sv h}^{-1}$

(ii) What thickness of lead (Pb) placed 1 m from the source would give the same protection?

09. (a) Describe the effects of ionizing radiation with biological material.

(b) Hence explain, How the following factors must be taken into consideration, when assessing a radiation hazard.

(i) Types of radiation

(ii) Dose rate

(iii) Total dose

(c) An experiment is carried out to investigate the effect on tissue of neutron beam and a γ -ray beam, having quality factors of 10 & 1 respectively. It is possible to insert a lead (Pb) shield into the γ -Ray beam for which the HVT in lead is 10 mm. With the shield in position, it is found that both beams produce the same absorbed dose. Without the shield, the two beams produce the same dose equivalent in the tissue sample. What is the thickness of the lead shield?

(d) Name the four "R"s in radiobiology

(e) Define RBE, OER, TR