**Answer all questions.**                                    **Submit on or Before 15th of March 2011**

1. a) Briefly describe the possible types of interactions between "light" and "Matter".
   b) Explain with the aid of diagram, the way that the laser light is produced.
   c) State the common types of lasers with examples and give the uses and the type of operation of each.
   d) A laser beam has a power of 50 mW. It has an aperture of 5 mm and it emits light of wavelength 720 nm. The beam is focused with a lens of focal length 0.1 m. calculate the area and the intensity of the image.

2. a) What do you understand by piezoelectric effect?
   b) Briefly explain with the aid of diagram on how Ultrasound is generated using piezoelectric crystal.
   c) List the advantages and disadvantages of medical Ultrasound.
   d) The distance between pulses representing ultrasonic reflections from opposite sides of a fetal head was recorded on the screen of a cathode ray oscilloscope as 5.6 cm when the time base was set to 25 µs /cm. Calculate the fetal head size assuming the speed of ultrasound in the head is 105 km/s.

3. a) Explain the Principle of Computerized Axial Tomography (CAT) and compare its method of    visualization with conventional X- ray methods.
   b) Define the activity and half-life of a sample of radionuclide. What is the relationship in between them?
   c) Describe on how the half-life of a sample of radionuclide can be found experimentally.
   d) A sample of radioisotope $^{15}$O of oxygen is used in positron Emission Tomography (PET) for the imaging of brain. It has an activity of 4.0 MBq and a half-life of 2 minutes.
       i) Calculate its decay constant.
       ii) How long will it take for the activity to fall to 1.5 MBq?

4. a) Explain how the principle methods used to control the radiation exposure are taken into consideration when assessing a radiation exposure.
   b) What is meant by external and Internal Radiation hazards?
   c) A worker is required to work in an area where he is subjected to different non uniform radiations, involving exposure of the whole body, the red bone marrow and the lungs. During a year the following doses are recorded

   | | |
   |---|---|
   | Whole body | -15 mGy from X radiation |
   | Red bone marrow | - 50 mGy from beta radiation |
   | Lungs | - 10 mGy form alpha radiation |

   Calculate the worker's effective dose and determine whether he has exceeded the permissible dose limits according to ICRP regulations.
   Tissue weighting factor for both red bone marrow and lungs is 0.12

5. a) List the main beam performing components of a typical medical Linear Accelerator (LINAC) with a block diagram.
   b) Why medical Linear Accelerators are preferred to be used with Cobalt (Co-60) units?
   c) What is an Isodose curve?
   d) Calculate the voltage across the adjacent tube of a LINAC which is used for producing X- radiation of maximum photon energy of 8 MeV, if the electrons are accelerated through a series of 25 drift tubes.

6. A gamma source produces a dose rate of 2.0 rem h$^{-1}$ at a distance of 1.0 m.
   a) Hoe far away must an occupational worker be so as not to exceed the Maximum Permissible Doses (MPD)?
   b) If the occupancy is 20 hours per week how far away must he work?
   c) What thickness of lead is required as a shield to enable him to work at 1.0 m for a full 40 hour week? Linear absorption co-efficient of lead for γ –beam, µ = 60 m$^{-1}$.