May 2006

Time allowed: 3 hours

Instructions for Examination:

- There are a total of SIX questions.
- All questions are of equal value
- All questions are to be attempted
- You may use diagrams, tables or lists in your answers.
- Answers should be given from a radiotherapeutic viewpoint.

1. 1. A superficial tumour with visible skin involvement is located just below the eye. On the planning CT, the oncologist marks the GTV and constructs a CTV which is 1.0cm wide, 1.5cm long, 1.0cm deep. The superior border of the CTV lies 0.5cm inferior to the centre of the bony orbital rim.
   (a) Explain how you would determine an appropriate PTV. (2 marks)
   (b) Choose three commonly available radiation treatment modalities and give a brief description of their limitations and potential usefulness in treating this tumour.(8 marks)

2.
   (a) Draw on the same graph, the central axis depth dose curves, measured in water, for:
      i. A 6 MV photon beam, 10 cm x 10 cm at 100 cm FSD,
      ii. A 3 mm Cu HVL orthovoltage beam, 10 cm x 10 cm at 50 cm FSD. (4 marks)
   (b) Explain the shape of the 6MV curve with reference to basic interactions of ionising radiation with matter. Explain why the orthovoltage curve differs from the 6MV curve. (6 marks)

3.
   (a) Consider an old 6 MV linear accelerator that is to be replaced with a new model accelerator, which produces 6 MV and 18 MV photon beams. Discuss the additional radiation interactions that need to be considered with this upgrade with regard to radiation protection requirements. Include in your answer the modifications which may need to be made to the room bunker. (8 marks)
   (b) Define absorbed dose and effective dose, providing S.I. units. Discuss the differences between these two terms.(2 marks)

4. Percent depth dose data for radiotherapy beams are usually tabulated for square fields, however the majority of treatments encountered in clinical practice require rectangular or irregularly shaped fields.
   (a) Describe two simple systems commonly used for equating different field shapes to square fields. (3 marks)
   (b) Draw a diagram to illustrate the differences in dose distribution between a 10cm x 10cm open field and a half-beam blocked 20cm x 10cm field. (4 marks)
   (c) How do Monte Carlo calculation methods provide optimal results for the situation described in 4b? (3 marks)

5. Write brief notes and where appropriate include the measurement units for the following:
   (a) Bolus
   (b) Isocentre
   (c) Bremsstrahlung
   (d) Linear energy transfer
   (e) Attenuation
   (f) Anthropomorphic phantom
   (g) Effective energy
   (h) Mass energy absorption coefficient
   (i) Inverse planning
   (j) Reference Air KERMA rate (1 mark each)

6. *In vivo* dosimetry is commonly requested for out of field eye lens dosimetry, where the eye is outside but close to the radiation field.
   (a) Identify 2 types of dosimeters commonly used for this application. (2 marks)
   (b) Describe the physical principles upon which the above dosimeters operate and the advantages and disadvantages of these dosimeters. (6 marks)
   (c) Comment on the confidence you would have in the measured dose reading from each of the in vivo dosimeters you describe.(2 marks)