Exam Report

Module Code/Title: **PHYS2007 – Medical Physics**

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Feedback comments:

The exam was taken by 39 candidates, and resulted in a final average of 51.3% and a rather high failure rate (23.1%) although the vast majority of these candidates did pass by compensation.

The usual format of a broad range of part A questions, together with a choice of 2 from 4 part B questions was maintained. Two of the part B questions were unseen, being based on newly re-organised parts of the syllabus; in this respect they were new in presentation more than in actual content. The numbers of students attempting each question was quite uniform, but the averages for the unseen questions were substantially lower.

Average mark for part A was ~60%, mostly because candidates provided good answers to some questions and partial/negligible answers to others, evidence that they had revised some parts of the course more deeply than other parts. Some students had clearly attempted (with varying degrees of success) to memorise the material with little real understanding, while others obviously understood well and gave the correct answer in their own words. Good marks on one of these questions often, but by no means always, match good marks on the others.

Question **B1** related to MRI, and was answered by approximately 15 students with a wide variation in quality. Some of the students had clearly seen a similar question on a past paper, and repeated the model answer verbatim. There were, however, some reasonable attempts at independently describing the three methods of spatial localisation, albeit with some very poor efforts mixed in.

The pulse sequence diagram was reasonably well reproduced in quite a few answers, although a few students had drawn (and described) a spin echo, rather than a gradient echo sequence. The written descriptions of the pulse sequence were very much a direct replication of the diagram without much evidence of a deeper understanding of the processes occurring. Some students provided a very poor description of the sequence, despite having drawn a good diagram, which showed a complete lack of understanding.

The section on T2 relaxation was, in some instances, answered well, but in these cases, students pretty much replicated the model answer. Other answers were very sketchy (even if, in some cases, other parts of the MRI question were answered well), and not that many students got all the correct parameters for T2* weighting, i.e. including the flip angle, rather than just TR and TE.

Question **B2** – was a new question relating to image concepts, attempted by around half the candidates, but with limited success. Very disappointingly part (a) was not answered all that well - a lot of students mixed up a definition that sounded like DQE with image resolution, the answers regarding the PSF showed that a lot had some idea of what it was but not very clearly. Only a minority understood how all three terms were related to one another. Most understood what contrast (part (b)) is but not all understood the advantages of using relative contrast. A lot of candidates got the plots correct in (c), some of them mixed up digital and film and some I got the distinct impression they drew the plots from memory but didn't understand what they were drawing. Answers to (d) ranged from the perfect to the nonsensical, most understood the role of quantum noise, some the role of inherent/systemic imager noise and there were some interesting takes on background noise.

Question **B3** related to Anger gamma camera design. In (a) most students were able to sketch the components and label them, although some confused the role of the light guide to spread the light from the scintillator across multiple PMTs. Some students forgot about the more 'external' components like collimators and shielding. For the position reconstruction (b), most students gave some decent diagrams, and spoke about how the position was estimated, but I was hoping for some technical description with 'centroiding' or 'first moment' featuring. Often it didn't. Fewer students discussed the energy reconstruction (from the sum of all PMTs as light from scintillator is proportional to energy deposit). The section on analog v digital was not done well - the point is that analog reconstruction uses resistor chains to combine the signals according to their position, and produces a single output - hence the individual signals are lost, and correcting for (eg) a faulty PMT is much harder. Also with digital systems, the individual position and energy signals can be used in an iterative fashion to apply better corrections.For (c) – the linearity map - a lot of students discussed energy, but this question was about the linearity of position reconstruction, and that is tested with a grid of equally spaced holes illuminated by a flood source of gamma-rays. Corrections can then be applied to return the reconstructed positions to a regular grid. For (d) most students could say that CZT systems provided better resolution (although practically not much) and some talked about efficiency. Few connected that this meant higher sensitivity / lower patient dose. Also, because each pixel is individually addressable and fixed in position, position reconstruction problems and edge effects go away. But sub-pixel resolution is impossible (cf the Anger camera where the resolution is better than the PMT size). Very few mentioned the better energy resolution allowing better scatter reduction or use of other isotopes. Finally (e) was done well, at least as far as the equal triangles derivation to get the collimator effect. Some students forgot to add the effect of the intrinsic detector resolution, which is important for very nearby sources.

Question B4 was another new question, on the physics of radiation energy deposition in radiotherapy. Most candidates were able to give a reasonable outline of how photons interact in tissue, but as usual (i) some got photons and protons mixed up, and (ii) there was inadequate discussion of the role of the secondary electrons in the process. Most candidates made a good attempt at sketching the dose-depth curves requested in (b), but the definitions of the build-up effect and kerma were weak, again relating to the lack of emphasis of the role of electrons in photon energy deposition. A few very good answers to (c) stood out, the the majority had no idea that that dose depth peak was related to the secondary electron range, so were unable to make a useful approximation. Finally (d) was answered well, with most students able to explain a Bragg Peak, and in some cases, a spread out Bragg Peak.