LTCC Models, exam question 2007–08

The setting of an exam question for a course such as the one I gave presents certain difficulties. The idea of the course was to introduce you to the ideas of modelling, introduce a range of topics and approaches from a variety of areas, and to encourage you to question assumptions and to think imaginatively about what may underlie a real problem.

So what can I ask questions on? Can I give you some new unseen subject and ask you to derive a mathematical model for it, and possibly do some analysis? — it would have to be a very simple model.

Given that the examination is open book, is it sensible for me to ask you to go through one of the examples given? — not sure if this is entirely sensible or worthwhile.

So what does this leave?

Possible topics:

- Question assumptions — give you a model and ask you to comment/criticise it (e.g., beer goggles, bits of Guinness model).
- Think imaginatively — what may be important in a problem (e.g., flow past a sphere, improvement on the Fibonacci model).
- Dimensional analysis — find how many non-dimensional parameters are needed to describe a model (Buckingham's theorem and the bomb).
- Model breakdown – spotting where assumptions break down (e.g., continuum hypothesis in free-surface cusps).
- Simple models:
  - some discrete models could be easy enough to tackle (similar to shell models, or Fibonacci model).
  - a one-dimensional conservation law model (similar to traffic flow).
- Complicated models such as for catalytic converters — a full derivation of a different model of similar comp[lexity, and an accompanying asymptotic analysis — only joking — obviously cannot be covered in an exam question (see comments above). May be suitable for the entire first year of your PhD.
- Dynamical systems — if you have studied these before any question would be too easy, and if you haven't any question would be too difficult. Either way not suitable.
- Bubbles in Guinness — did try and find a question that required you to have a refreshing glass of Guinness each during you exam. I failed — sorry.

Expect a multi-part question where some of these topics are covered. Parts could be along the lines of the following (but with new models):

1. What physical effects may affect the flow around a sphere?
2. Comment on the model for "Beer Goggles" by Nathan Efron.
3. What quantities affect the size of the blast sphere soon after the detination of an atominc bomb? How many nondimensional parameters will describe the model. How would your model break down if the bomb was detonated underground?
4. ...

However, I will not use examples directly from the lectures. For open ended questions it is important to come up with the important ideas (flow past a sphere: speed, size, fluid viscosity) but from then on any sensible idea (I judge what is sensible) gets you more credit.

I hope you enjoy you exam.

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