Typical questions to be asked in oral examination

You can imagine the word "please" inserted before every request.

Any answer could be partly written to help you explain.

I imagine that the questioning and answering will last for about $15\,\mathrm{min}$, so all the following may not be asked. Other questions might be stimulated by the discussion.

- Can you explain briefly how this relation was obtained, and what it means:
$$\overline{u^2} = \bar{u}^2 + \overline{u'^2}.$$
- What is the difference between Bernoulli's equation and the energy conservation equation in integral form (as described in our lecture notes – many people make no distinction in the naming).
- Discuss the concept and use of resistance in open channel flow.
- Discuss the concept of wetted perimeter in open channel flow equations.
- Why is it simpler to use momentum conservation rather than energy conservation in the long wave equations?
- It seems that the relative grain size (diameter divided by mean depth) when used in equations for resistance does not have a strong influence. Do you have any physical explanation for this? (To be honest, the lecturer does not have such an explanation, he just has the mathematical explanations on pages 33 and 36 of the notes)
- In the long wave equations, which are generally for non-uniform, time varying flow, to compute the local resistance, just the local flow velocity and channel geometry are used. Why is this a good approximation?
- In steady sub-critical river flow, what is the effect of an obstacle such as a bridge pier on the flow (a) downstream and (b) upstream of the bridge?
- Describe the way in which a detention reservoir operates so as to reduce the maximum discharge downstream.
- On a sheet of paper, or verbally, describe Euler's method for the numerical solution of an ordinary differential equation.
- Here are the long wave equations in terms of cross-sectional area A and discharge Q:
$$\begin{aligned}
&\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = i, \\
&\frac{\partial Q}{\partial t} + \frac{\partial}{\partial x}\left(\beta \frac{Q^2}{A}\right) + \frac{gA}{B}\frac{\partial A}{\partial x} = gA\tilde{S} - \Omega Q\left|Q\right|.
\end{aligned}$$
Explain the physical significance of each term in each equation.
- Can you explain why the long wave speed c_0 at which flood waves travel (to first approximation) is greater than U, the mean speed of the water in the river? (In fact, $c_0 \approx \frac{5}{3}U$)?
- Consider the *Advection-diffusion equation*, which is a good approximation to flood motion:
$$\frac{\partial v}{\partial t} + c_0\frac{\partial v}{\partial x} - \frac{Q_0}{2B_0 S}\frac{\partial^2 v}{\partial x^2} = 0.$$
What is the effect of the term with the second derivative?
- The bridge mentioned earlier causes the water to rise $30\,\mathrm{cm}$ above the level that would exist without the bridge, in water of depth $1.5\ \mathrm{m}$. How might you calculate the upstream effects of the bridge?
- What effect on a stream does a section of increased resistance have?
- Describe how the discharge in a stream is measured and calculated with the aid of a current meter.

- Describe the concept and use of a Rating Curve, relating the discharge in a stream to the water level. If you can, describe any problems that that method has.
- Gradually over time, an "armour layer" builds on the bed of a stream, where individual particles are removed and the spaces between bed particles become filled with smaller particles. The bed becomes smoother. What would be the effect on the discharge calculated for a given water level?
- The lecturer shows Figure 10.1 from the lecture notes, the "modified Shields diagram", showing dimensionless stress Θ plotted against dimensionless grain size D_*. Briefly describe the features of the diagram. Why is this diagram simpler to use to calculate bed stability than the conventional Shields diagram with grain Reynolds number $u_* D/\nu$ plotted horizontally?
- Why do laboratory experiments have difficulty in giving quantitative results for sediment transport and/or deposition?
- Sketch the typical bed forms of (a) Ripples and (b) Dunes.
- Do *you* have an explanation for the formation of sediment point bars on the inside of river curves? (None was given in the lectures – sorry!).
- Describe the concept of eddy viscosity. Why is it greater than the viscosity of the fluid in laminar flow?
- Describe the effects of dispersion in real streams.
- Give an example of something you liked about the subject and/or agreed with. Any others?
- Give an example of something you did not like about the subject and/or *disagreed* with. Any others?