Informal Feedback on the ME20021 Examination (May 2016)

In general, my part of the paper (Q3 and Q4) was well done. I got the impression that Q3 was found to be easier, and certainly virtually everyone attempted this question. There was one script where neither of my questions were attempted — I find this strange because (i) we had the tutorials and the office hours, and I get the impression that everyone who asks me a question gets a satisfying reply, and (ii) even someone who is desperate to get as many marks as they can will give something go dredging up half-remembered even peripheral stuff just to grab a few marks, and yet there was nothing, not even a question number with neither a question mark on the next line nor a "haven't a clue, mate".

Very very pleased with the uptake of the old integration by parts method. Very very few went astray on that. Nice work guys.

Question 4. I'll do these in reverse order because I have little to say about this one.

Part (a). Bookwork. I warned everyone, and almost everyone did this perfectly . There were a few who made a sign error on the integration by parts (sine integrating to +cosine rather than to −cosine) and yet the answer was correct.... Hmmmm, I check these things. Getting the wrong sign in the answer means that something had gone adrift earlier and it should be easy to check where.

Part (b). This was an old problem sheet question. Perhaps that is why this part was answered quite well. Some rederived the FST of a second derivative to find $\mathcal{F}_s[\partial^2 y/\partial x^2]$, but that was the point of part (a).

Part (c). Not at all well answered in general. The FST integral may be changed from $\int_0^\infty$ to $\int_0^{ct}$ because of the range of x over which $H(ct - x)$ is nonzero. Then it is a quick sprint to the answer with an easy integral.

Part (d). This wasn't part of the equivalent problem sheet question. A quick sketch of $H(ct - x)$ will show that it is a shock wave moving with velocity c in the positive x-direction. Some remembered the *physical meaning* answer from a very different problem sheet question, but that didn't apply here because this solution is very different.

Hats off to the person who attempted an anaglyphic sketch of the solution, and yes, I do have anaglyphic glasses (red/blue 3D imaging) and so I tried it out. The only problem was that there were black lines on the sketch which spoiled the effect. Otherwise it wasn't too bad. An heroic and impressive try.

Question 3. A fairly standard question of its type.

Part (a). Many drew a rudimentary diagram — excellent. Then cosines were selected as required by the boundary conditions. The whole procedure went very well indeed in the majority of cases. The sole issue I had was that the constant term, $\frac{1}{2}A_0$, was not included by the significant minority of candidates. Often, though not always, it appeared suddenly in part (b)!

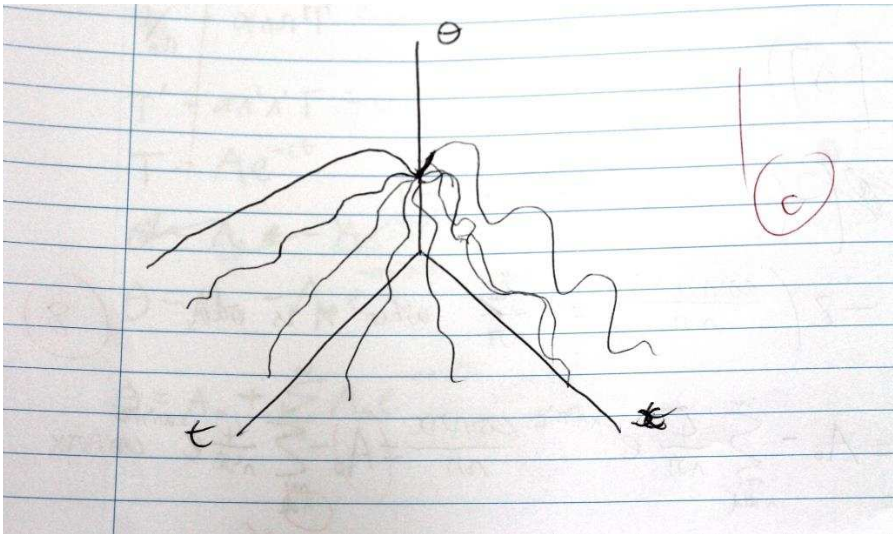
One person took almost four pages to answer part (a), having adopted the textbook approach which I describe in section 3 of the online notes and which is very long-winded and slow. Another took two pages for this. The great majority took less than half a page, and the very switched-on ones did it correctly in only a few lines.

Part (b). Integrations went well for the very great majority. Sometimes A_0 was ignored. One person said that it could be ignored because there wasn't a formula given on the exam paper; there was — the formula for A_n is valid for $n = 0, 1, \cdots$. A few didn't include a sufficient number of brackets (seems habitual, given the rest of their exam script) and a correct $(1-2x)\cos n\pi x$ on one line became $1-2x\ \cos n\pi x$ on the next, and then the student didn't see the virtual brackets.

Part (c). Wow, this was crazy time! Not many got this right. The biggest error that was made was by not imposing the zero derivative boundary conditions at $x=0$ and $x=1$ and by allowing the whole profile to descend to zero, rather than tend towards $\frac{1}{2}A_0$. In other words, the sketch resembled the analogous case where the temperature is fixed at zero on the two boundaries.

Some sketched the evolution of the value of θ at the centre of the interval, $x=\frac{1}{2}$. The question asked for the evolution of the profile with time, rather than of a single point with time.

The most interesting diagram was the following.



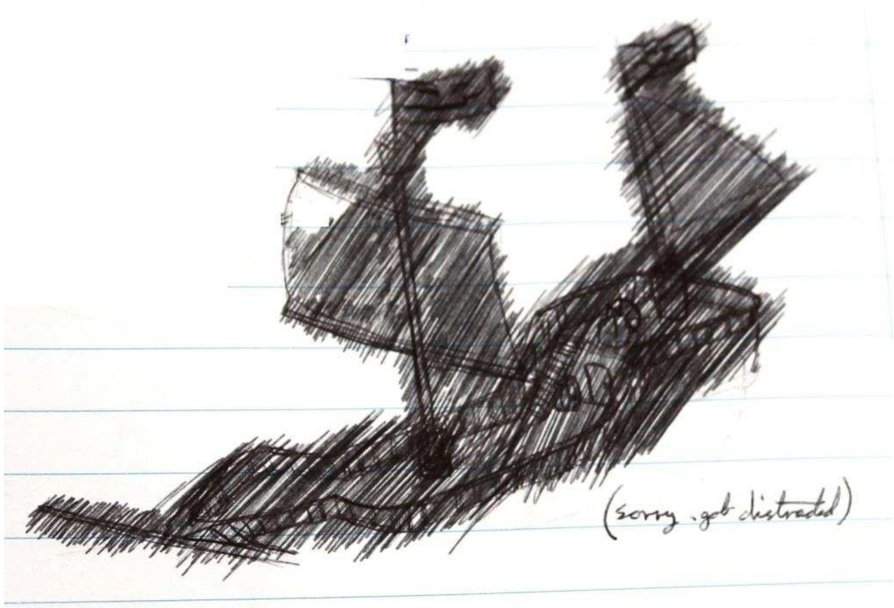
Part (d). Appallingly badly answered. So much so that I will list some of answers for your entertainment. The question was: What is the significance of $\frac{1}{2}A_0$? Here they are:

1. It makes the question harder.
2. It is a constant.
3. It is twice the value of θ at $n=0$. [“At $n=0$” actually makes no sense.]
4. It is of no significance.
5. It exists because it is a half-range series. [Not true for a sine series.]
6. Starting temperature across the rod. [It was a quadratic.]
7. This shows that there is an initial temperature at $t=0$. [Isn't that the role of the initial condition?]
8. A_0 is when $n=0$.
9. It operates on the basis of the value of T with the cos function added to it, hence dictating the shape and amplitude of the waveform.
10. It is the steady-state component of DC component as usually described when dealing with waves. [Must be an IMEE!]
11. As observed, $\frac{1}{2}A_0$ signifies the middle value of the function, the value around which the function oscillates both positively and negatively (inflection point).
12. $\frac{1}{2}A_0$ is used to represent a constant value A_0. The $\frac{1}{2}$ is for convenience.
13. A_0 is added in the full Fourier Series.
14. The minimum temperature.

15. If the solutions do not meet the requirements or the boundary conditions, as additional term is brought in to correct the discrepancy in order to meet the requirements.
16. A constant that shifts the temperature profile.
17. $\frac{1}{2}A_0$ is $\theta(0,0) = 1$.
18. To displace the whole graph up and down.
19. $\frac{1}{2}A_0 =$ offset. [Another IMEE?]
20. It is the median value of the initial profile. [Should be the mean value.]

The true answer is: the ultimate uniform temperature and/or the mean of the initial temperature profile.

Clearly I didn't make the exam long enough. Someone found time in the middle to design a galleon....



....and with a bit of luck you might manage to do that for real next year if someone offers a suitable Group Business and Design project. You will need to improve your shading-in skills, though, and be a little more inventive with your choice of colours. But in the high pressure enviroment of an examination, it is pretty good.