This document includes my solution proposal and comments for exercises included in the Tutor Marked Assignment 1 for the course M000 The Course Name .

Contents

Question 1

This is an example question in which we use exemplify with calculus of variations. [1]
Consider the $S[y] = \int_a^b dx F(x, y, \dot{y})$, where $\dot{y} = y' = \dfrac{dy}{dx}$, as seen in Brunt's book[2], show that the Euler-Lagrange equations are:

$$\frac{d}{dx}\frac{\partial F}{\partial y'} - \frac{\partial F}{\partial y} = 0$$

Solution. Example Question
Using the Gateaux derivative (not *gâteau*, that is french for cake) on S, we can write

$$\left.\frac{d}{d\varepsilon} S[y + \varepsilon h]\right|_{\epsilon=0} = \left.\frac{d}{d\varepsilon} \int_a^b dx F(x, y + \varepsilon h, y' + \epsilon h')\right|_{\epsilon=0} \tag{1}$$

Did you really believe I'd show the whole thing? This is just an example.
As seen in 1 the bar for evaluation looks as big as the derivative operator or integral sign. That is because we are properly telling LaTeX, where the evaluation symbol will be applied. LaTeXdoesn't care about the meaning of that, but if we keep our semantics right, we'll get good results on the output.
Now you want to write the O term, you could do it with $\mathcal{O}$ or just with O as $\mathcal{O}(\epsilon^2)$, this is a common situation.
Maybe you need to write the *then* which would be $\implies$, or the arrow for limits $\to$.
For example, if $f : \mathbb{R} \to \mathbb{R}$ is a continuous, then $\lim_{x \to a} f(x) = f(a)$.
Another interesting use case is trying to keep equations aligned.

$$\begin{aligned}
x^2 + 2px + q &= x^2 + 2px + q + 0 \\
&= x^2 + 2px + q + (p^2 - p^2) \\
&= x^2 + 2px + p^2 + (q - p^2) \\
&= (x + p)^2 + (q - p^2) \\
&= (x + p)^2 + (q - p^2)
\end{aligned}$$

And with this we see a simple manipulation of completing the squre in which you have all the equations aligned by the equal sign.
More over, you could do two columns [3]

$$\begin{aligned}
1 + 1 + 1 &= 1 + (1 + 1) & 2 + 2 + 2 &= 2 + (2 + 2) \\
&= 1 + 2 & &= 2 + 4 \\
&= 3 & &= 6
\end{aligned}$$

[1] Remark that this is just an example of common operations you find in this type of problem
[2] Bruce van Brunt: The calculus of variations, 1st ed. (Universitext), 2004.
[3] For this example, I had no idea what to use, so I used a simple sum

In this case, as you can see, the text went over one page, which is fine. But without this paragraph, the black square that states the end of the solution will be on the next page by itself.
If you know how to fix it, let me know.

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This is an example of a question that uses more Number Theory type of objects.
For example, without using the solution environment, I'll be showing the congruence, which can be written as mod, observe how this previous one doesn't introduce a white space before the *mod* word, but this one $\mod$ does. Here we use a lot of the symbol for congruence, $\equiv$, which are three lines.
Another thing we use is the sum over divisors as $\displaystyle\sum_{d|n} a(d)$, or we use *many conditions* in the summation index as $\displaystyle\sum_{\substack{\text{prime } p\leq x \\ p\equiv 3 (\bmod 10)}} \frac{1}{p}$, now If you notice, I'll continue this paragraph with no meaning just to exhibit how the summation, as big as it is, still respects line. This is because we are using display mode for the equations everywhere. I find that more comfortable, but it might not be convenient in any document.
Now, if we want to write a continuous fraction, we must go through the pain of writing everything manually.

$$\frac{1}{1+\frac{1}{1+\frac{1}{2}}}$$

But it looks nice, good luck with that.
Now for a table you can use the regular LaTeXenv for it

m	$\Re\{\underline{\mathfrak{X}}(m)\}$	$-\Im\{\underline{\mathfrak{X}}(m)\}$	$\mathfrak{X}(m)$	$\frac{\mathfrak{X}(m)}{23}$	A_m	$\varphi(m)$ / °	φ_m / °
1	16.128	+8.872	16.128	1.402	1.373	-146.6	-137.6
2	3.442	-2.509	3.442	0.299	0.343	133.2	152.4
3	1.826	-0.363	1.826	0.159	0.119	168.5	-161.1
4	0.993	-0.429	0.993	0.086	0.08	25.6	90
5	1.29	+0.099	1.29	0.112	0.097	-175.6	-114.7
6	0.483	-0.183	0.483	0.042	0.063	22.3	122.5
7	0.766	-0.475	0.766	0.067	0.039	141.6	-122
8	0.624	+0.365	0.624	0.054	0.04	-35.7	90
9	0.641	-0.466	0.641	0.056	0.045	133.3	-106.3
10	0.45	+0.421	0.45	0.039	0.034	-69.4	110.9
11	0.598	-0.597	0.598	0.052	0.025	92.3	-109.3

Table 1: I stole this table from StackExchange[1]

Maybe it's also worth using the symbol for Asymptotically equal $f(x) \sim g(x)$.

[1] The URL for that is https://tex.stackexchange.com/a/112382