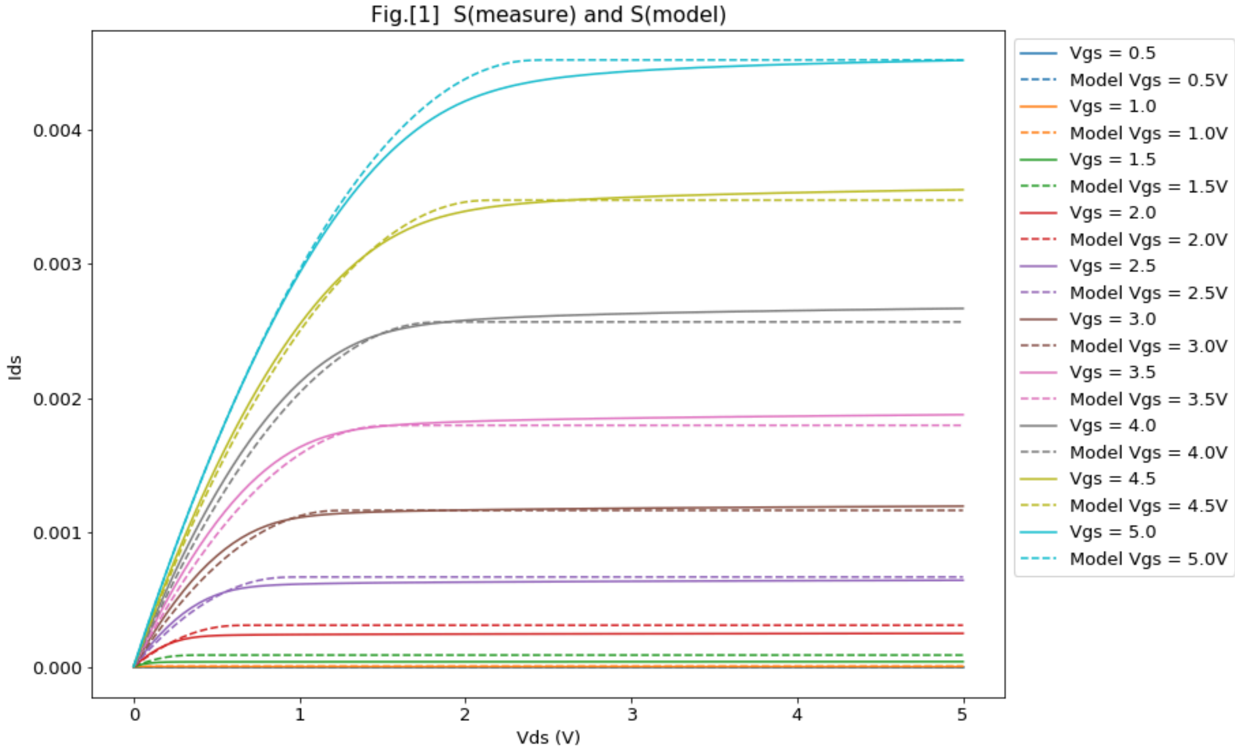
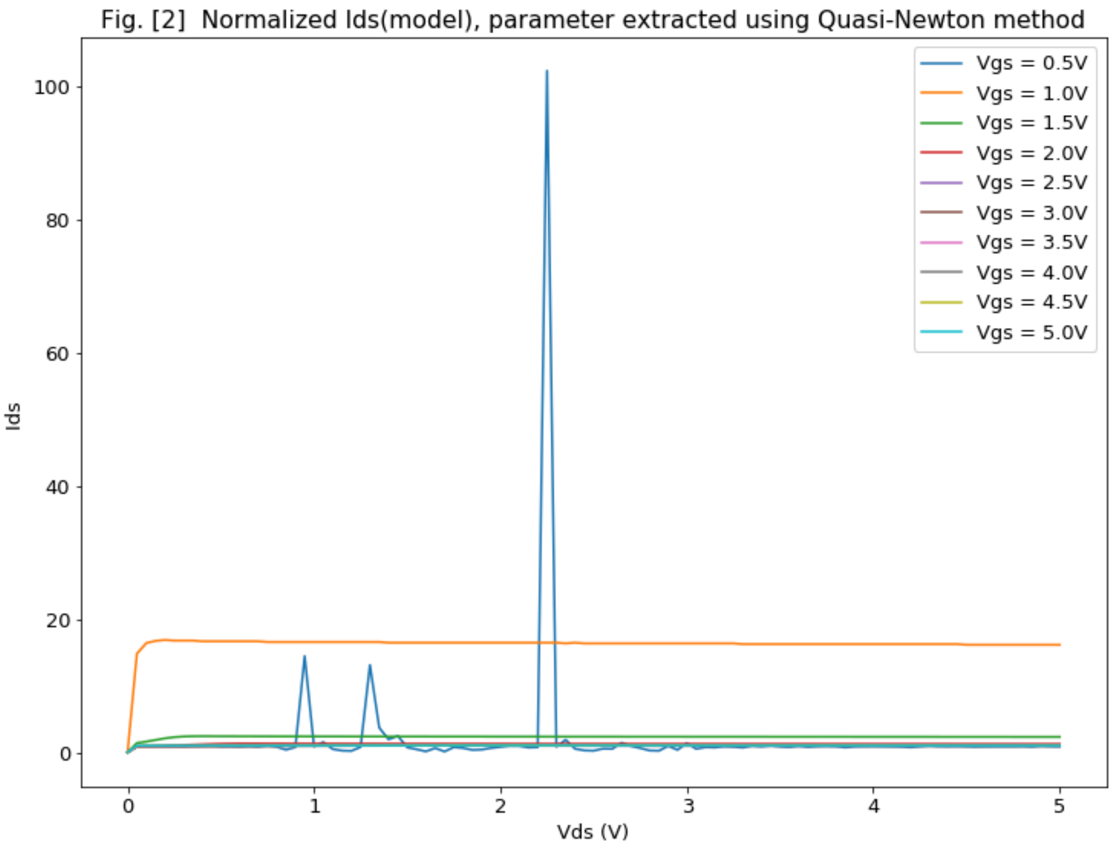
Visual Report of Task 3, 5, 7

- **Task 3:** *Plot of S(measure), co-plotted with S(model) using Quasi-Newton method*

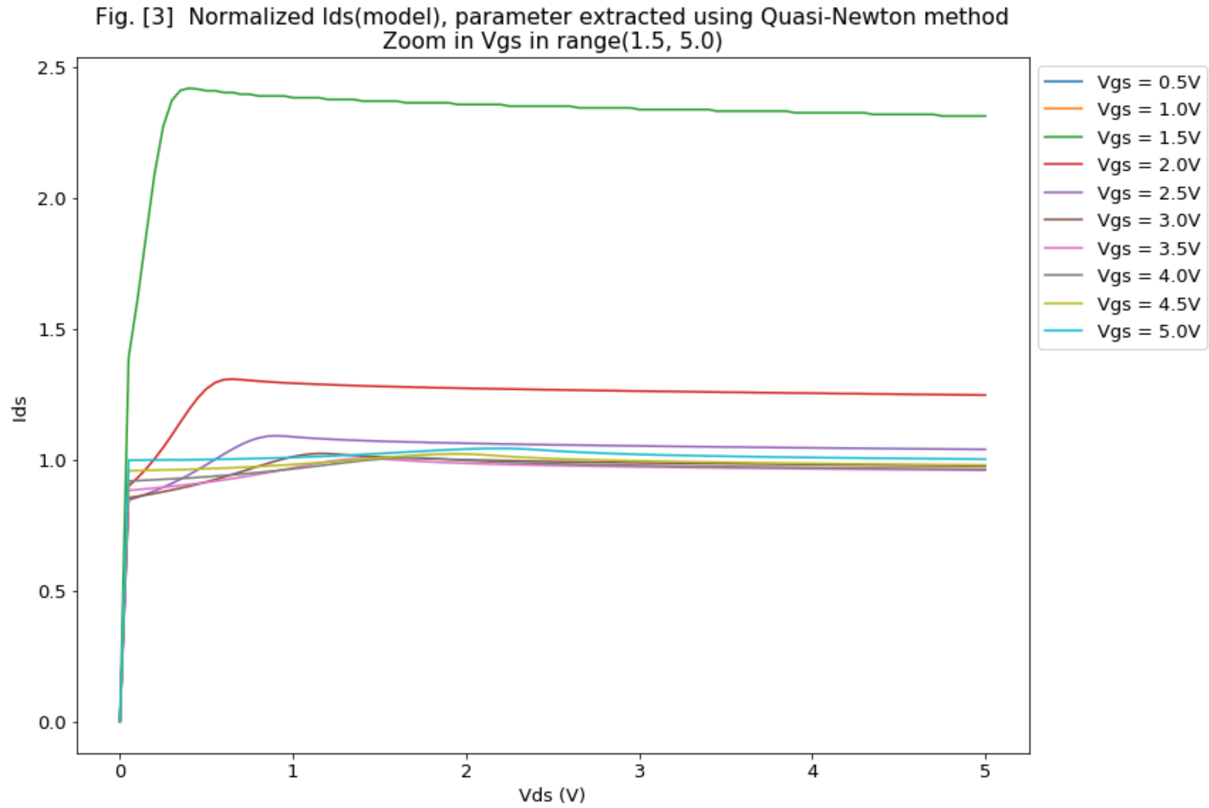


The dotted curves are the data generated from parameters extracted from Task 4.

- **Task 5.1:** *Plot of S(model) = Ids(model) / Ids(measure)*



It could be seen that for Vgs = 0.5V and Vgs = 1.0V, the Ids(model) is a lot larger than the Ids(measure), and the other curves are zoomed out. Therefore, another plot that zoom in with Vgs > 1.0V is plotted as below:



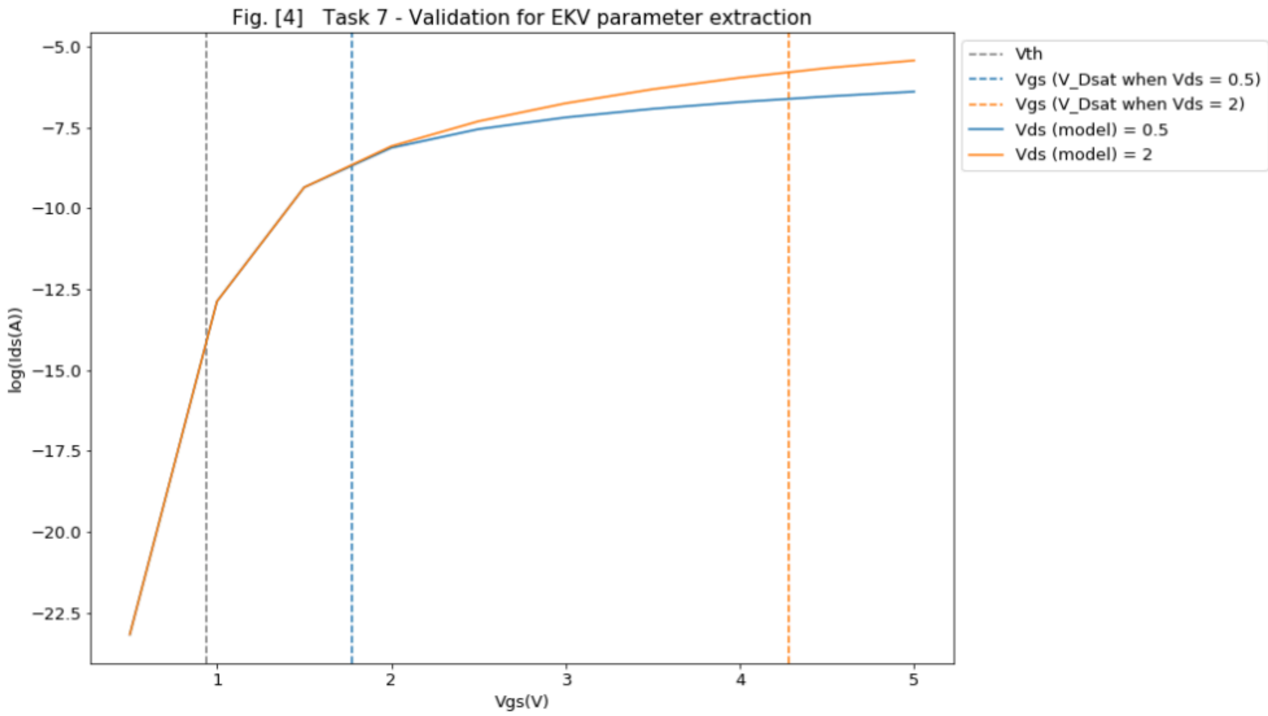
From the two plots above, it could be concluded that the smaller the Ids, the bigger the errors. Especially when Vgs = 0.5V, the Ids(model) even oscillates to as large as 100 times of Ids(measure), although with un-normalized data, loss function's value V is extremely small and within the magnitude of 10^(-6).
The reason could be that with smaller Ids(smaller Vgs), the loss function is less dominated by the errors of the small Ids, therefore ||V|| seems to be not affected too much by the small Ids points.

As a result, the larger Ids points are fit better by the least-square-estimation, because their errors weigh more in the iterative solver and would thus be optimized more by the iterative solver.

Without normalization, the larger Ids data points have better performance than the smaller Ids data points. Therefore, normalization is required to enhance the smaller Ids data points' performance by assigning equal weight of errors as the larger Ids data points.

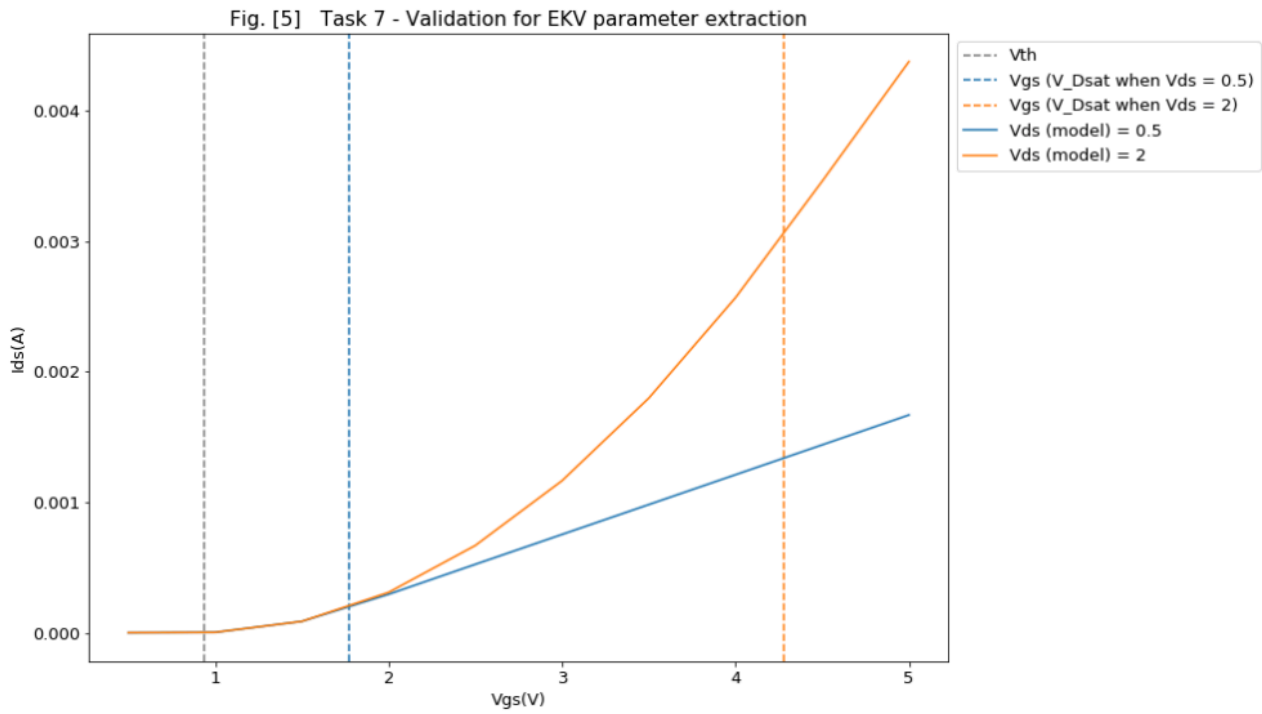
- **Task 7.1, Visual Validation of Iterative Solver Using Quasi-Newton Method**

   a) *Plot of S(measure) and S(model) using Quasi-Newton method (As in Fig. [1])*
   b) *Plot of log(Ids(measure)) vs. Vgs with two Vds: (As in Fig.[4])*



To observe how Ids is influenced with different Vgs and Vds values, several vertical lines could be drawn on of Fig. [4] to better delimit the boundaries of the Vgs = Vth, Vds > Vdsat, and Vds < Vdsat.

To better relate to the approximation in Task 7, Fig. [4] is re-plotted as Ids vs. Vgs, instead of in the logarithm form, as in Fig. [5]:



a) For $V_{gs} < V_{th}$ (the grey dotted vertical line at around $V_{gs} = 1$):
It could be concluded that the I_{ds} is almost completely determined by V_{gs}, and insensitive to V_{ds}, because the two curves are overlapping with each other before V_{th}.
Also According to Auto_Report's Task 7's numerical validation, I_{ds} is exponential to V_{gs}.

b) For $V_{gs} > V_{th}$, and $V_{ds} > V_{dSat}$:

The largest V_{gs} that guarantees $V_{ds} > V_{dSat}$ would be calculated from $V_{gs} = \frac{V_{ds}}{\kappa} + V_{th}$, and the delimiters for $V_{ds} = 0.5$, and $V_{ds} = 2.0$ are respectively the blue and orange dotted lines in Fig. [5].

It could be seen that when $V_{ds} > V_{dSat}$ (before the blue dotted line), the I_{ds} is almost completely determined by V_{gs}, and insensitive to V_{ds}, because two curves are overlapping before the blue dotted line.

According to the Auto_Report's Task 7's numerical validation, I_{ds} is quadratic to V_{gs}.

c) For $V_{gs} > V_{th}$, and $V_{ds} < V_{dSat}$:

Right after the blue dotted line, these two curves begin to diverge, and V_{ds} starts to having effects on I_{ds}.

According to the Auto_Report's Task 7's numerical validation, I_{ds} is quadratic to V_{ds}.

It could be concluded from the visual and numerical (in Auto_Report.txt) validation, that the implementation of iterative solver using Quasi-Newton method is correct.