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Altair HyperStudy 2019 Tutorials

HS-1620: Settings Up a Flux Model

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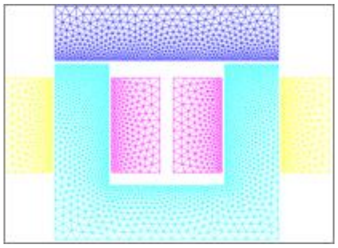
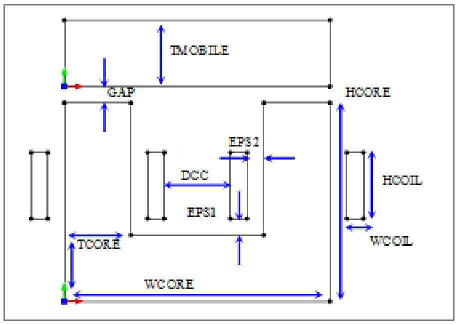
HS-1620: Settings Up a Flux Model

An electromagnetic actuator is a device that converts an electric current into a mechanical output. In this tutorial, you will be investigating the relationship between actuator dimensions and the mechanical force output. The actuator is composed of an U magnetic core, mobile magnetic part, and two coils supplied by an amp-turn number. The finite element model is created and analyzed by Flux. The Flux model also contains the input variables and output responses of interest.

Electromagnetic actuator and its Finite element model



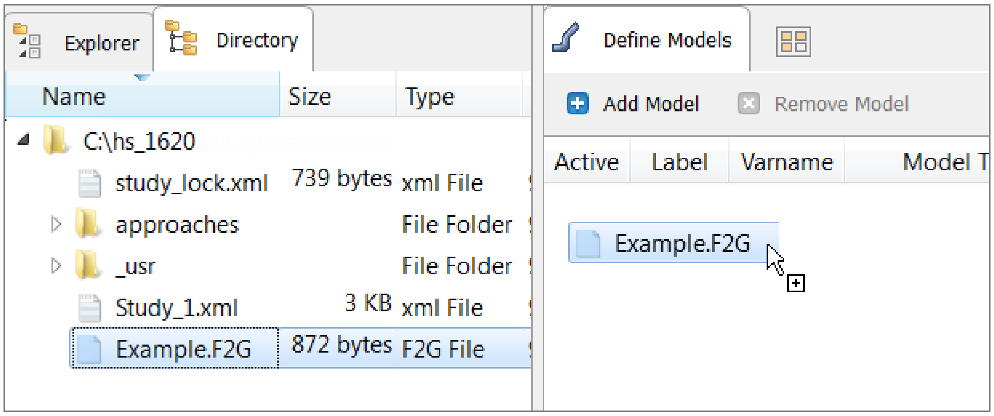
Input variables

The files used in this tutorial can be found in `<hst.zip>/HS-1620/`. Copy the tutorial files from this directory to your working directory.

Note: This tutorial requires registration of the installed version of Flux Software with HyperStudy. For details, see Flux Model.

Step 1: Perform the Study Setup

1. Start HyperStudy.
2. To start a new study, click ***File*** > ***New*** from the menu bar, or click on the toolbar.
3. In the **HyperStudy – Add** dialog, enter a study name, select a location for the study, and click ***OK***.
4. Go to the **Define models** step.
5. Add a Flux model by dragging-and-dropping the `Example.F2G` from the **Directory** into the work area.



The Resource, Solver input file, Solver execution script, and Solver input arguments fields become populated.

	Active	Label	Varname	Model Type	Resource	Solver input file	Solver execution script	Solver input arguments
1	☑	Model 1	m_1	Flux	C:/hs_1620/Example.F2G	hst_input.hstp	Flux (HstSolver_Flux)	-batch

6. Click ***Import Variables***. Ten input variables are imported from the `Example.F2G` file.
7. Go to the **Define Input Variables** step, and review the input variables.

	Active	Label	Varname	Lower Bound	Initial	Upper Bound	Comment
1	☑	AT	dv_1	900.00000 ...	1000.0000 ...	1100.0000 ...	PHYS ...
2	☑	TCORE	dv_2	18.000000 ...	20.000000 ...	22.000000 ...	GEOM ...
3	☑	WCOIL	dv_3	16.200000 ...	18.000000 ...	19.800000 ...	GEOM ...
4	☑	HCOIL	dv_4	31.500000 ...	35.000000 ...	38.500000 ...	GEOM ...
5	☑	DEPTH	dv_5	18.000000 ...	20.000000 ...	22.000000 ...	GEOM ...
6	☑	EPS1	dv_6	4.5000000 ...	5.0000000 ...	5.5000000 ...	GEOM ...
7	☑	GAP	dv_7	1.3500000 ...	1.5000000 ...	1.6500000 ...	GEOM ...
8	☑	EPS2	dv_8	0.9000000 ...	1.0000000 ...	1.1000000 ...	GEOM ...
9	☑	TMOBILE	dv_9	18.000000 ...	20.000000 ...	22.000000 ...	GEOM ...
10	☑	DCC	dv_10	4.5000000 ...	5.0000000 ...	5.5000000 ...	GEOM ...

8. Go to the **Specifications** step.

Step 2: Perform the Nominal Run

1. In the work area, set the **Mode** to ***Nominal Run***.
2. Click ***Apply***.
3. Go to the **Evaluate** step.

4. Click ***Evaluate Tasks***. An `approaches/nom_1/` directory is created inside the study directory. The `approaches/nom_1/run__00001/m_1` sub-directory contains the run files.
5. Go to the **Define Output Responses** step.

Step 3: Create and Define Output Responses

1. Review the output responses.

	Active	Label	Varname	Expression	Value
1	☑	FEM_FORCE	r_1	v_1[0] ...	171.90637

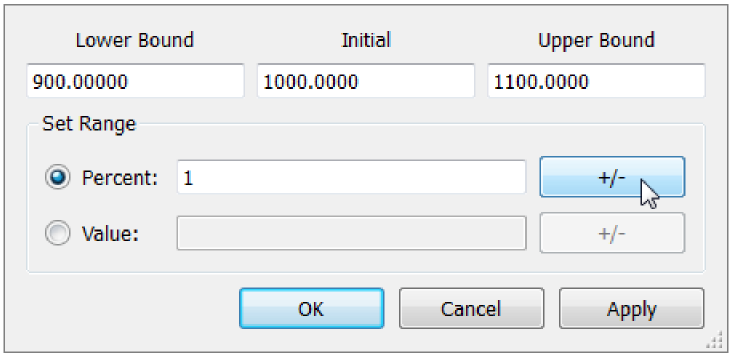
2. Click ***Evaluate Expressions*** to extract output response values.
3. Click ***OK***. This complete the study setup.

Step 4: Run a Hammersley Stochastic Study

1. In the **Explorer**, right-click and select ***Add*** from the context menu.
2. In the **Add - HyperStudy** dialog, add a **Stochastic**.
3. In the **Select Input Variables** step, clear the **Active** checkbox for GAP.

	Active	Label	Varname	Lower Bound	Initial	Upper Bound	Comment
5	☑	DEPTH	dv_5	19.800000 ...	20.000000 ...	20.200000 ...	GEOM ...
6	☑	EPS1	dv_6	4.9500000 ...	5.0000000 ...	5.0500000 ...	GEOM ...
7	☐	GAP	dv_7	1.4850000 ...	1.5000000 ...	1.5150000 ...	GEOM ...
8	☑	EPS2	dv_8	0.9900000 ...	1.0000000 ...	1.0100000 ...	GEOM ...
9	☑	TMOBILE	dv_9	19.800000	20.000000	20.200000	GEOM

4. For each input variable, adjust the lower and upper bounds, which will be used to calculate statistical distribution settings, in this case the variance of normal distribution.
   a. In the **Initial** column, click **...**.
   b. In the window, enter `1` in the percent field and click **+/-**.
   c. Click ***OK***.



5. Go to the **Specifications** step.
6. In the work area, set the **Mode** to ***Hammersley***.
7. In the **Settings** tab, verify that the **Number of runs** is 100.

   Note: If you are using a laptop with a Win64 operating system, 32 GB ram, Intel Core i7 CPU, it may take around 40 minutes to run 100 Flux simulations. To reduce the run times, change the Number of Runs to a lower value. However, a high number of runs is necessary for better statistical accuracy.
8. Click ***Apply***.
9. Go to the **Evaluate** step.
10. Click ***Evaluate Tasks***.
11. Go to the **Post processing** step.
12. Click the ***Scatter 2D*** tab to plot correlation values.

    Correlation measures the strength and direction between associated variables. Correlation coefficients can have a value from -1 to 1; -1 indicates a strong but negative correlation and 1 indicates a strong and positive correlation.

    The correlation values for variables AT, DEPTH, and TCORE with Force are 0.80, 0.43, and 0.39, which indicates that Force is correlated to AT and Force is somewhat correlated to DEPTH and TCORE. These three correlations are positive, meaning that you should expect to see an increase in Force corresponding to an increases in AT, DEPTH, and TCORE. You can also expect to see no changes in Force corresponding to changes in other variables. DEPTH and TCORE are somewhat correlated to FORCE, therefore you may see deviations from these predicted behaviors.

	1	2	3	4	5	6	7	8	9	10
AT (1)	1.00	0.01	0.00	-0.00	-0.02	-0.02	0.02	0.03	0.05	0.80
TCORE (2)	0.01	1.00	-0.02	-0.01	-0.00	-0.02	-0.03	-0.01	-0.02	0.39
WCOIL (3)	0.00	-0.02	1.00	-0.02	-0.03	-0.00	-0.02	-0.02	0.00	-0.06
HCOIL (4)	-0.00	-0.01	-0.02	1.00	-0.01	0.03	-0.01	0.00	-0.02	-0.06
DEPTH (5)	-0.02	-0.00	-0.03	-0.01	1.00	-0.02	-0.00	-0.01	-0.01	0.43
EPS1 (6)	-0.02	-0.02	-0.00	0.03	-0.02	1.00	-0.00	-0.01	0.00	-0.04
EPS2 (7)	0.02	-0.03	-0.02	-0.01	-0.00	-0.00	1.00	0.01	-0.00	0.01
TMOBILE (8)	0.03	-0.01	-0.02	0.00	-0.01	-0.01	0.01	1.00	0.02	0.06
DCC (9)	0.05	-0.02	0.00	-0.02	-0.01	0.00	-0.00	0.02	1.00	0.02
FEM_FORCE (10)	0.80	0.39	-0.06	-0.06	0.43	-0.04	0.01	0.06	0.02	1.00

You can visualize these correlations in the Scatter2D plot. In the plot for FORCE vs AT, you can see the design cloud follows a nice pattern of increasing Force with increasing AT. In the plot for WCOIL vs FORCE, you should not observe any relationship between the two.