TUTORIAL FOR SIS TOOL.

The SIS tool is used in the course for state minimization, state assignment, technology Mapping, timing optimization, solving minimum covering problem etc,.

The SIS tool is installed on the unix machines and is activated using the following command.

Type the command "**sis**" at the command prompt as shown in the snapshot below:

.....

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis>
```

1. Reading Files in the SIS package.

Different file formats can be read in the SIS package. They include the <u>PLA</u>, <u>BLIF, KISS, EQN</u>, SLIF and ASTG formats. The files are read in these formats by typing the following commands at the command prompt.

> read_pla <filename>
> read_blif <filename>
> read_kiss <filename>

For example this is shown in the snapshot below,

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis> read_pla ece274.pla
```

In the snapshot shown above the filename is ece274.pla and the format read is PLA format.

.....

Different libraries can also be read in the SIS package. The command for reading libraries is:

> read_library <library name>

2. Print Statements in SIS

Few print commands provided in the SIS package are shown below.

> print_stats

Print the current network status, which includes the network name, number of primary inputs (pi), number of primary outputs (po), number of nodes (nodes), the number of latches (latches), and the number of literals.

> print [-n] [-d]

Print all the nodes in the node-list in sum-of-product form. For the option –n, the nodes are printed in the negative form. The option –d prints the don't care set of the function.

> print_io [-d] [node-list]

Print both fanin and fanout list for each node in the node-list. Absence of nodelist implies all the nodes in the current network. When the –d option along with the nodelist given the command gives the outputs which are effected by the given inputs.

Similarly, the SIS package has other print functions like print_gate, print_library, print_delay, print_clock etc. These additional functions are used for various other applications and description of these commands is given in the <u>Detailed SIS</u> commands manual in the Tutorial section of the course webpage.

The Snapshot below shows the functioning of the print statements in the SIS package.

3. Writing to Files in SIS

Different file formats can be written in the SIS package. They include the PLA, BLIF, KISS, EQN, SLIF and ASTG formats. The files are written in these formats by typing the following commands at the command prompt.

> write_pla <filename> > write_blif <filename> > write_kiss <filename>

For example this is shown in the snapshot below,

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis> read_pla ece274.pla
sis> print_stats
ece274.pla pi= 4 po= 2 nodes= 2 latches= 0
lits(sop)= 11
sis> espresso
sis> write_pla write274.pla
sis>
```

In the snapshot shown above the filename is write274.pla and the format written is in PLA format.

4. Using Espresso within the SIS tool

The Espresso can be run while in the SIS tool by typing the command espresso at the SIS prompt. No options are allowed when running the Espresso program from within the SIS tool. The previous snapshot shows the execution of Espresso from within the SIS tool.

5. State Minimization using Stamina

The SIS package provides a state minimization program called Stamina.

Running the Stamina program

Follow the steps described below to run the Stamina program.

1. Run the sis program. Typing "**sis**" at the command prompt results in the following display:

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis>
```

- After this, the "kiss file" (Description of the State machine) is entered. The kiss file needs to be present in the current directory. Then, the command "read_kiss" is used. (Refer to the "Reading Files" section of this manual).
- 3. Run Stamina program. At the "sis" (See the snapshot below) prompt, type the command "state_ minimize stamina"

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis> read_kiss ece274.kiss2
sis> state_minimize stamina
Running stamina, written by June Rho, University of Colorado at Boulder
Number of states in original machine : 6
Number of states in minimized machine : 2
sis> write_kiss result.kiss2
sis>
```

The result is as shown above in the snapshot. It is a minimized state machine. The resultant kiss file is written to result.kiss2 using the "write_kiss" command.

6. State Assignment using Nova

Nova is used for state assignments in FSMs. The state machine should be minimized using Stamina before performing state assignment with Nova.

Running the Nova program

Follow the steps described below to run the Nova program.

1. Run the sis program. Typing "**sis**" at the command prompt results in the following display:

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis>
```

- After this, the "kiss file" (Description of the State machine) is entered. The kiss file needs to be present in the current directory. Then, the command "read_kiss" is used. (Refer to the "Reading Files" section of this manual).
- 3. Run Stamina program. At the "sis" (See the snapshot below) prompt, type the command "state_ minimize stamina"

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis> read_kiss ece274.kiss2
sis> state_minimize stamina
Running stamina, written by June Rho, University of Colorado at Boulder
Number of states in original machine : 6
Number of states in minimized machine : 2
sis>
```

4. Run Nova program. At the "**sis**" (See the snapshot above) prompt, type the command "**state_ assign nova**" ("**print_stats**" is used before and after running Nova only to show the changes being made to the network by Nova)

5. The network is then minimized using the Espresso program available on SIS.

The result is as shown in the snapshot below:

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis> read_kiss ece274.kiss2
sis> state_minimize stamina
Running stamina, written by June Rho, University of Colorado at Boulder
Number of states in original machine : 6
Number of states in minimized machine :
sis> print_stats
ece274.kiss2 pi= 2 po= 1 nodes= 1 latches= 0
lits(sop)= 0 #states(STG)= 2
sis> state_assign nova -e h
Running nova, written by Tiziano Villa, UC Berkeley
sis> print_stats
ece274.kiss2 pi= 2 po= 1 nodes= 3
                                          latches= 2
lits(sop) = 42 #states(STG) = 2
sis> espresso
sis> print_stats
ece274.kiss2 pi= 2 po= 1 nodes= 12 latches= 2
lits(sop)= 25 #states(STG)= 2
sis> write_blif ece274.blif
sis>
```

It is a minimized state machine. The resultant blif file is written to ece274.blif using the "write_blif" command. The nova program in the above snapshot assigns states using one hot assignment (because of the –e h option used with the nova program). Additional information on <u>options available for NOVA</u> <u>program</u> is posted in the tutorials section on the course webpage. The espresso program is run to further reduce the literals in the two level logic.

7. Technology Mapping

The sis tools provide with a technology-mapping tool called "**map**". The network file (blif, kiss, pla, eqn, etc) can be mapped to a technology library. SIS offers many existing libraries and new custom libraries can be added.

Follow the steps described below to run the Map program.

- 1. Read the network file. The network file can be in blif, pla, Kiss, eqn formats. (Refer to the "Reading Files" section of this manual).
- 2. Read the library to which you want to map the design ("**read_library**"). The libraries are provided in the directory sis_lib.
- 3. The network is then decomposed using the command "**decomp**". (It is one of the transforms used to break down large functions into smaller pieces, usually at the cost of introducing a few more literals).
- 4. Map the network on to the specified library using the command "**map**". Various options are available in this command like –s, -W etc. These options can be found by typing the command "**map** –h".
- 5. Write the technology-mapped network into any of the above file formats.(Refer to the "Writing to Files" section of this manual).

The following is a snapshot showing the above steps.

```
>sis
UC Berkeley, SIS 1.3 (compiled 25-Sep-96 at 12:07 PM)
sis> read_blif ./sis_lib/ece274.blif
sis> read_library ./sis_lib/nand-nor1.genlib
sis> decomp
sis> map
sis> write_blif ece274out.blif
sis> quit
```

The network for the equation "f = ab + c+d" when mapped using a nandnor library consisting of only a 2 input nand gate, 2 input nor gate and inverter is mapped in the following manner. The Map program gives the delay values, arrival times, area consumed etc., of the network.



The detailed SIS program description is posted on the Course Web Page in the Tutorials section or can be <u>downloaded here</u>.