Instructions on Flyback Converter simulation exercise

- After downloading LTspiceIV from http://www.linear.com/company/software.jsp , install the program.

- Download the library and schematic files from the course homepage (Flyback.rar)

If your LTspice is installed in the folder C:\Program Files\LTC\LTspiceIV then deal with contents of the "lib" folder which you downloaded as follows:

1. Add the downloaded file "irgpc50k.asy" (under "sym\Misc" folder) into the corresponding folder in your PC

   C:\Program Files\LTC\LTspiceIV\lib\sym\Misc.
2. Add the downloaded file "irgpc50k.mod" (under "sub" folder) into the corresponding folder in your PC

   C:\Program Files\LTC\LTspiceIV\lib\sub
3. Replace the file "standard.dio" in your PC with the downloaded one (under "cmp" folder)

   C:\Program Files\LTC\LTspiceIV\lib\cmp

- You may place the downloaded schematic files (*.asc) wherever you like.
- Start the program LTspiceIV.
- Open one of the schematics you have downloaded.
- Select "Simulate" from the pull-down menu and then "Control Panel". Select "SPICE" tab and change the setting for "Abstol" from 1e-012 to 1e-006.
- Perform the simulation by selecting "Simulate" and then "run" (from the pull-down menu)
- Use the current/voltage probes that appear automatically when you get the cursor close to any component in the schematic file in order to plot any desired waveform.
- After choosing the plot window (Flyback.raw) you can add and delete traces (waveforms) by pressing "Plot Settings" from the pull-down menu.

The various asc-files included are variants of the original file where different snubber circuits have been added.

What to investigate?

Investigate the general functionality of the flyback converter (and its snubbers) using the current and voltage probes under LTSpice. Do not hesitate to create different versions of the schematic file in order to study "what if" scenarios (as long as you have a copy of the original file).

Some guidance questions to help you through your investigation Provide a screenshot(s) and/or an answer when requested to do so!

1- What is the switching frequency of the MOSFET? What is the duty cycle used? *Provide an answer!*

2- Observe the current and voltage waveforms across each component in the circuit and notice how that relates to Kirchoff's laws for voltage and current.

3- Generate the voltage waveform across the MOSFET and the diode?
What is the MOSFET and diode voltage when it conducts?
What is the blocking voltage in each element when it's off?
Write down an expression for each case (in terms of V_{in}, V_{out} and turns ratio n=n2/n1)
Provide screenshots and answers!

4- Is the flyback transformer used in the circuit a step-up or a step-down transformer?
What is the transformer ratio?
How the transformer ratio is related to inductance values on both sides of the transformer?
Provide an answer!

5- Generate the instantaneous power loss waveforms for each of the power semiconductor elements (power transistor and diode)!
You can do so by right-clicking the title of the current/voltage waveforms in the .raw file and then entering the mathematical expression needed.
When you have the power loss waveform ready, left-click the title of the waveform and move the cursor with the arrows in order to locate any point on the curve. Press the "control" button and the left click of the mouse simultaneously to investigate the average power loss and the total energy lost over a chosen interval.
Provide a screenshot for the instantaneous power loss waveform for each semiconductor element and the result showing average power loss and energy lost over a certain interval!

6- Change the Coupling factor from 1 to 0.998. Generate the voltage waveform across the MOSFET. Observe the voltage spikes/overshoots, what level does it have compared to the actual blocking voltage. Reduce the coupling factor further to 0.98. Observe again! Compare? Do you have an explanation for the phenomenon?

Provide screenshots and answer!

7- Observe the ripple in the output voltage/current. How does that change when you change the output capacitance value to 50 µF (instead of 1 mF). Record screen shots before and after!

Provide screenshots!

8- Observe and record a screenshot of the reverse-recovery time for the power diode (t_{rr}) *Provide a screenshot!*