24.536 Reactor Experiments and 407.403 Advanced Nuclear Lab

HW #1: UMLRR Overview and Some Data Acquisition Tasks

Introduction

The goals of our first class was to give an overview of the UMass-Lowell research reactor (UMLRR) facility and to highlight some of the data acquisition tools that will be used within this course. Your first homework (HW) also emphasizes these topics, with two separate parts, as follows:

1. Answer several general questions concerning the UMLRR facility.
2. Perform the same series of tasks as done in class using the Matlab-based **umlrr_data** GUI.

The specific tasks and deliverables for each of these topic areas are described below:

Task 1: Answer several general questions concerning the UMLRR facility

1. The UMLRR can operate in both forced flow and natural convection mode. What are the licensed power level and flow direction in both modes?
2. Briefly describe the geometry of a typical fuel element within the UMLRR -- rough size, material composition, basic layout, etc.
3. Identify and briefly describe two of the experimental facilities within the UMLRR.
4. Describe the control mechanisms within the UMLRR -- how many devices, what material, and what is their primary function?
5. Describe the primary mechanism for the production of radioactive N-16 in water-cooled reactors. Also discuss the decay scheme for N-16 and identify the primary safety concern here. Finally, within the context of this question, clearly identify the main purpose of the "holdup tank" in the primary loop of the UMLRR.
6. In the current M-5-8 core configuration, what element type is in position E2? How about D9? Also identify the grid location, the general geometry configuration, and the material composition of the current flux trap element.
7. What do the following acronyms stand for? MTR, LEU, FNI
8. The reactor pool contains roughly 76000 gal (288 m^3) of water. If the secondary cooling system is turned off and the heat loss from the reactor pool is negligible (i.e. assume no energy loss), estimate the maximum heat-up rate in ^oF/hr and ^oC/hr of the pool water. Explain your logic…
9. The result to the previous question implies that the pool water is a good energy storage medium. What is another important function of the 24 ft (7.3 m) of water above the reactor core?
10. In forced flow mode, the primary flow rate through the core is about 1700 gpm (6.43 m^3/min). At the maximum licensed power level for the UMLRR, estimate the coolant ΔT across the core in ^oF and ^oC. Based on this result, explain why the UMLRR is not used to generate electricity.

Answer each of the above questions fully and include your responses and calculations, as needed, as part of your complete package for HW#1.

Task 2: Perform the same tasks as done in class using the Matlab-based umlrr_data GUI

The goal of this task is to reproduce the **umlrr_data** GUI demo done in class -- please refer to the **data_acquisition_demo.pdf** file that is in the Dropbox share folder for an overview of what was done. In particular, you should perform the following tasks:

1. Download the **data_gui_ver4.1p.zip** and **xenon+temp_test_081612.zip** files -- the goal here is to setup and test run the **umlrr_data** GUI as demonstrated in class. Unzip these files into two different folders. In Matlab, make sure that the **umlrr_data** folder is in Matlab's path and make the folder with the sample history file from Aug. 2012 the default folder in Matlab. Now type ***umlrr_data*** in the Matlab command window to open the GUI and browse for the *.hst file of interest (only one is available for this demo).
2. After getting familiar with some aspects of this tool, set the start time of interest to 10:03:00 and the duration to 4 hours. Also set the "Interval for Data Smoothing" to 30 seconds. Finally, hit the button "Save Reduced Data File" to write a simple ascii data file for later use. In general, you can name this file as desired but, for compatibility with the next step, here you should call it **xenon_temp_feedback_081612.dat**. Also, please be sure to close the GUI before running another Matlab script file ("odd" behavior can occur if you don't…).

   Note: The specific times given here refer to the local UMass-Lowell time -- you may need to adjust for any time zone differences or for "daylight saving time". The point here is to capture the time regions with the reactor operation of interest -- that is, for this case, the roughly four hours of constant power operation just after the reactor reaches full power.
3. Now run the **fdbk_rho_081612.m** Matlab script file to process and plot some data from the **xenon_temp_feedback_081612.dat** "reduced data file" that you just generated. Did this work as expected? Do you understand what is happening inside this Matlab code? This just gives an example of how one might process and analyze data from a particular experiment -- you should try to follow the internal comments and coding so that you can follow the basic logic here...
4. As a final deliverable for this task, modify the Matlab code to add the name of your team to the title for the plot of "Reactivity Changes Versus Time". Briefly comment on your experience here and be sure to include your slightly modified plot as part of your HW package (only this one plot is necessary to show that you have completed this task properly). The idea here is to get familiar with the Matlab code to read and process this ***.dat** file -- several sections of this Matlab code will be needed in subsequent HWs, so you should get comfortable with the various tasks done here so that you can repeat these in future assignments...

Documentation and Submission of HWs

In general, I expect a professional, well-written, semi-formal report for each HW assignment in this course. Thus, documentation for each assignment should include the following:

1. Brief answers and/or descriptions for each of the specified tasks should be typed in Word, with proper format, grammar, spelling, etc. Please include any requested Matlab plots and/or

any output print that may be needed directly within the Word file. Once complete, **please convert this to pdf format** for transmittal as part of a single zip file.

2. If Matlab codes are requested as part of the HW, be sure to include these within the single zip file. Note that I do NOT intend to run each of your individual Matlab codes. However, as necessary, I may review these files for correctness/accuracy and run a few of them to verify the results of your analysis. Please include plenty of internal comments to help document your coding. **Note: No Matlab files are needed for HW#1.**

3. Since typing mathematical equations and derivations is somewhat tedious and time consuming, neatly hand-written developments are acceptable, as appropriate, for each task. If formal derivations are done by hand, please scan these into a file and include directly into the Word document or as a separate file. If a separate file is included, please refer to this appropriately as part of your discussion -- however, please try to keep as much as possible directly in your main Word document for each HW. **Note: For HW#1, Tasks 1.8 and 1.10 should have some calculations to support the development of your solution.**

4. Finally, put everything together in a single zip file -- **only one zip file per HW please** -- and **email this to me by 4 pm on the Sunday afternoon (UML time) prior to the next class meeting**. This will give me some time to briefly review your HW before our next class on Tuesday morning. The naming convention for the HW files should be

   HW#_team_name.zip

   Clearly the **#** should be the HW number (i.e. HW1, HW2, etc.) and the **team_name** should be the name selected for your study team for this class. Also, please be sure to include each team members' names and student IDs in the main Word document as part of your HW (**please only submit one HW package for each study group**). So that there is no confusion, also include your full names and student IDs within each document within the single *.zip file (i.e. in the Word file, in each Matlab code near the top of the code, etc.).

Please use the above instructions and format for each HW assignment in this course…