MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Nuclear Engineering

22.033 Nuclear Engineering Design Project

Fall 2004

Time & Place: Monday and Wednesday 11:00–12:30pm; Room 24-115
Recitations with TA to be arranged weekly

Instructor: Professor Andrew C. Kadak
Office: 24-202, Tel: x3-0166, email: Kadak@mit.edu

Assistant: Pete Yarsky
Office: NW13-220 / x3-5730: Yarsky@mit.edu
Office Hours: TBD or by appointment

Text: *None – 2003 Mars Mission Report and Project Prometheus Information*

Homework: Assigned weekly to be done for next class depending on task

Recitation: Weekly, to be arranged

Grading:

Class Participation	20%
Personal Work Contributed to Project	50%
Final Project Report	20%
Oral Presentation Quality	10%

Material Orientation:

Problems in nuclear engineering often involve applying knowledge from many disciplines simultaneously in achieving satisfactory solutions. Each student will be asked to support a team design project that integrates the profession of nuclear engineering. This term's project description is attached. It involves developing a conceptual design for a moon based power plant that can be used to test the manned Mars mission needs planned in the future. Should the number of students be large, an additional project to support the Prometheus mission will be added.

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Name: _____

MIT Address: _____ Dept. _____

Telephone: _____ FAX: _____

E-mail: _____

Field and Specialization (interest area): _____

_____

_____

Course Background (list any courses that are especially relevant to this subject and give colloquial course title, text and MIT number, if applicable):

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2004 Design Project Definition

On January 14, 2004, President Bush announced a new vision[1] for US space exploration calling for among other things space exploration beyond low-earth orbit. He recommended that the US renew lunar exploration to "enable sustained human and robotic exploration of Mars and more distant destinations of the solar system". Part of this goal was to conduct the first extended human expedition of the lunar surface as early as 2015. These activities are meant to test new approaches, technologies and systems to support sustained human space exploration to Mars and other destinations.

In 2003, the design course focused on developing nuclear technologies for to power propulsion systems and habitat for manned Mars missions[2]. The past design project developed new nuclear power plants for the generation of electricity for the high power requirements needed for the plasma rockets and a power plant to support life on Mars for 15 years. This year's project will build on the learning of the past project with a focus on the new Presidential vision for the first phase of the development of Manned Mars exploration.

Project Scope:

Development of a Lunar Nuclear Power Plant that Can Be Used for the Mars Mission

Since the test bed for manned exploration of space will be our moon, we would like to develop a nuclear energy plant that can be used for manned Mars missions. In the past study, a CO_2 cooled reactor was developed since the Martian atmosphere is largely CO_2. This choice of coolant would eliminate the need to carry it to Mars. For lunar and Martian applications, this choice needs to be revisited as would the core design and the balance of plant since the mission requirements are much shorter than previously assumed (5 years versus the design basis of 15 assumed in the previous study). The plant design would be targeted to about 100 kwe.

The design challenges are:

1. To determine the best technology for use in both environments.
2. Improved power conversion cycle efficiency with low coolant inventory and cycle simplicity
3. Reactor control and reactivity swing
4. System modularity
5. Novel heat rejection methods
6. Fuel design
7. Shielding for human access
8. Deployment
9. Long term reliability and maintenance
10. Start up/Shutdown/Control

The expectations for this course are that a conceptual design be developed and justified by the end of the term with a report and presentation to the MIT community in the last week of classes.

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[1] Report of the President's Commission on Implementation of United States Space Exploration Policy, "A Journey to Inspire, Innovate and Discover", June 2004, http://www.nasa.gov/pdf/60736main_M2M_report_small.pdf

[2] "Mission to Mars: How to Get People There and Back with Nuclear Energy", 22.033 Design Report, Spring 2003, Dostal, Gezelius, Horng, Koser, Palaia, Shwagerhaus, Yarsky.