Research Notes

Sampling Curriculum

How can a student get a realistic idea of what is ahead for him in engineering or science before he has to choose a specific field of study? Is there a way for him to try out possibilities in different areas before he is committed to one? Offering courses in the freshman year that give glimpses of what it can be like at the upperclass or graduate student's level is one answer to questions like these.

Changes in curriculum two years ago reduced the number of requirements for freshmen and, for the first time, allowed them to choose electives. Consequently, some faculty interested in demonstrating what is available in their own academic fields have been experimenting with new courses for Caltech freshmen.

One such course is E5, a one-term laboratory in engineering and applied science. This course introduces the student to the field at an earlier stage than before, and teaches the elements of the experimental method in an engineering context.

Within the framework of a formal course, the project combines features of actual laboratory research, especially the fact that the outcome of most experiments is unexpected. The student has considerable freedom in selecting experiments, and insofar as possible the experiments are small "facilities" rather than set procedures. After he is introduced to the apparatus and instrumentation, the student has considerable latitude in the direction his effort can take—depending on his interest—and in the depth and sophistication to which it can be carried —depending on his ability.

The experiments, designed and built by nine members of the division faculty, are grouped into four categories (solid-state and nuclear engineering, wave propagation, fluid mechanics, and mechanical-chemical engineering). Students select one from each group for the term's work, and spend an average of two weeks (six lab hours) on each experiment.

Fifty freshmen elected E5 during the two terms it was offered. (Five reelected it in order to work for a second term on the experiments they had not chosen the first time.) Of the 34 freshmen who chose engineering as a major at the end of 1969, 25 had taken E5. "Presumably the engineering faculty now knows its incoming students better than it has in the past," says Bradford Sturtevant, associate professor of aeronautics who is in charge of the program. "We also hope the converse is true."

Counting Photons

The 200-inch Hale telescope at Palomar Observatory, designed in the thirties and built in the forties, continues to improve as a research tool because of the revolution in electronics that has come about since the telescope began operating in 1948. The latest improvement is a photoelectric spectrometer that can record incredibly small amounts of light in 32 wavelengths simultaneously.

The designer of the spectrometer is J. B. Oke, professor of astronomy and staff member of the Mt. Wilson and Palomar Observatories, who is using the instrument to look at quasars, globular clusters, and dying stars such as white dwarfs.

Oke is also observing "peculiar" galaxies (Seyfert, N-type, Zwicky-Compact, and Markarian galaxies), which have minute, extremely bright nuclei. The nuclei of these galaxies share many characteristics with quasars: They are variable, have strong emission lines; most of the radiation from them probably comes from a nonthermal source, and may be synchrotron radiation. Some of the brightest of these galaxies have luminosities in the range of the least luminous quasars. Research in the last two or three years lends support to current theories that some galactic nuclei are not simply denser concentrations of the stars and gases that surround them.

The spectrometer that observes these galaxies and stars was built at a cost of about $250,000. It is unique in that it subtracts the light of the night sky automatically, making it possible to observe objects fainter than the sky itself. The device can actually count the light, photon by photon, and can obtain information from objects as dim as 22nd magnitude stars. Because such stars, even with the 200-inch telescope, are not visible to the eye, a television system will eventually be added to help the observer guide the telescope to the faint objects.

The spectrometer is installed under the 200-inch mirror at the Cassegrain focus of the telescope. The electronic controls and data system were built in the Observatories' astroelectronics laboratory under the supervision of staff member Edwin Dennison. The work was supported by the Advanced Research Projects Agency and NASA.

Measuring Marsquakes

Mars, midway in size between the earth and moon, is an important link in planetary studies; more information about its evolution may yield a clearer picture of our own planet.

Geophysicists at Caltech and four other universities are now building a lightweight instrument that will, in a few years, be making detailed studies of Mars' seismicity or lack thereof. Such information would give scientists important information about Mars' internal stress and its evolution as a planet.

The development of the equipment is part of the Martian Seismic Experiment, a NASA-supported project. The work is led by Don L. Anderson, professor of geophysics and director of Caltech's seismological laboratory, where technicians are designing and assembling the two-pound instrument.

The device will be similar to those developed for the Ranger, Surveyor, and Apollo lunar missions. It will monitor background noise continuously, as well as count the Marsquakes and supply other detailed data. It is expected to detect movement as small as one ten-millionth of an inch and to speed up its transmission of data when a quake occurs. Thus equipped, the Mars experiment should determine whether observable seismicity due to quakes and meteor impacts exists and, if so, what its frequency is.

Obviously, not all of the questions can be answered by a single short-lived experiment, but researchers have a lot to look for in the first results. Radar measurements indicate large-scale topographic features such as mountains and plains, and craters have been photographed by Mariners IV, VI, and VII. These indicate that Mars is a differentiated planet and may possess a crust. The small seismometer can tell whether Mars is now dormant or if there are internal activities causing movement of the surface.

The level of extremely small temblors might also serve as a rough indicator of meteorological activities such as wind and atmospheric pressure. Such phenomena interact effectively with the ground to produce seismic energy and can be detected over large areas by seismic observatories.