Words well worth recalling and reflecting upon even, nay especially, today.

We have for long wanted to present accounts of great experiments in physics done over the years. Now we have found our man – Amit Roy – and he tells us this time about the discovery of the transistor. One has to make a conscious effort to realize the magnitude of the changes that this has led to over the past half century, in practically every sphere of life.

In an article on cognitive psychology, Kamala Mukunda takes us behind the retina to tell us how and where we actually 'see' anything in its wholeness; in the Classroom Section we learn of the difficulties of teaching Darwinian evolution. The almost universal tendency to think along Lamarckian lines here reminds us of a parallel situation in physics, where students instinctively think of mechanics in the old Aristotelian manner rather than along Galilean–Newtonian principles. And in Reflections we turn to L J Mordell for a 'second opinion' on G H Hardy's 1940 classic '*A Mathematician's Apology*'.

Emmy Noether (1882–1935)

Amalie Emmy Noether was born in Erlangen, Germany as the first child and only daughter of Max Noether, a professor of mathematics at the University of Erlangen. Hers was an upper middle class German family. Following the trend prevalent in those days, she studied French and English after school and qualified as a language teacher at the age of 18, passing the official examinations of the state of Bavaria. By then, Emmy was more attracted to mathematics and wished to study it seriously. Although born into a mathematical family, (her father was a well known mathematician), she had to rebel against her family in order to pursue her mathematical education.

At that time the University of Erlangen would not admit women students although more liberal minded universities in Germany like Göttingen and also the neighbouring countries like France, England and Italy had already started doing so. Emmy had to take special permission to be admitted as an auditor in the University of Erlangen from 1900 to 1902. This helped her to study and pass the state matriculation

examination in 1903 so that she could attend the university at Göttingen in 1903–1904. After this she returned to Erlangen and was enrolled in the Faculty of Mathematics as the only woman with 46 male students. She passed the final examinations for a doctorate in mathematics with a fine dissertation on algebraic invariants in 1908.

She started working at the Mathematical Institute at Erlangen without a formal appointment, concentrating on her own research in algebra and also helping her father who was handicapped by polio. She began to receive recognition for her deep results. In 1915, she moved to Göttingen on their invitation to assist the mathematical giants David Hilbert and Felix Klein, in problems arising out of their interest in Einstein's general theory of relativity. Einstein himself appreciated her penetrating mathematical thinking in his letter to Hilbert in 1918. Yet a regular faculty appointment for her at Göttingen was not forthcoming, in spite of the best efforts of Hilbert and other mathematicians. Hilbert managed to provide her teaching opportunities by announcing that she was his assistant and having her lecture instead. Only in 1919 was she was appointed as a lecturer, and that too for a meagre stipend!

She continued her excellent research work at Göttingen until the Nazis dismissed her in 1933 because of her Jewish origins. Thanks to her worldwide reputation, she received an immediate offer from Bryn Mawr College, a women's university in the USA. She accepted in 1933 the position of guest professor there. But in 1935 her end came suddenly after an operation for the removal of a tumour.

Emmy Noether's mathematics was abstract, original and deep. Her contributions to the theory of algebraic invariants and the theory of ideals in rings are very significant. She laid down the broad foundations of the modern abstract theory of ideals and also a great deal more in modern algebra. The celebrated mathematician B L Van der Waerden says, "For Emmy Noether, relationships among numbers, functions and operations become transparent, amenable to generalisation and productive only after they have been disassociated from any particular objects and have been reduced to general conceptual relationships." The approach as developed by Emmy Noether and her pupils has come to be known as the *Noether School*.

Suggested Reading

[1] E T Bell. *Development of Mathematics*. McGraw Hill Book Company, New York, 1945.
[2] P Rothman. Women in the History of Mathematics. *Interdisciplinary Science Reviews*. 22. 1997.

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