

**Mathematics 3820H – Mathematics from medieval to modern times**

TRENT UNIVERSITY, Fall 2016

**Assignment # $\pi$**

**Equations and Poems**

*Due on Tuesday, 1 November.*

You may recall that Indian mathematicians wrote up much of their work in verse, some of which got a little whimsical. For example, here is a problem posed by Bhaskara (II) in a book dedicated to his daughter Lilavati:

The square root of half the number of bees in a swarm  
Has flown out upon a jasmine bush;  
Eight ninths of the swarm has remained behind;  
And a female bee flies about a male who is buzzing inside a lotus flower;  
In the night, allured by the flower's sweet odour, he went inside it  
And now he is trapped!  
Tell me, most enchanting lady, the number of bees.\*

1. Restate the problem posed by Bhaskara as an equation and solve it. [2]

The Persian polymath Omar al-Khayyami developed geometric techniques for finding the positive real roots of cubic and quartic equations. In modern notation, his method for solving cubics can be described as follows:

To solve the cubic equation  $x^3 + ax^2 + b^2x + b^2c = 0$ , intersect the hyperbola  $y = \frac{bc}{x} + b$  with the circle  $(x + \frac{1}{2}(a + c))^2 + y^2 = \frac{1}{4}(a - c)^2$  and find the point of intersection other than  $(-c, 0)$ .

2. Verify that al-Khayyami's method for solving cubic equations actually does find positive real roots, if such exist. [4]
3. Restate al-Khayyami's method in whimsical verse. [4]

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\* This translation of Bhaskara's problem is given in *The Heritage of Thales*, by W.S. Anglin & J. Lambeck, Springer Verlag, New York, 1995, ISBN 0-387-94544-X, p. 113.