

# Lectures on Challenging Mathematics

## MO2M1 Introduction to Olympiad Mathematics Module 1

Fall 2016

Zuming Feng  
Phillips Exeter Academy and IDEA Math  
zfeng@exeter.edu

©Copyright 2008 – 2016 Idea Math

*“Cogito ergo Sum” – “I think, therefore I am”*

René Descartes (1596-1650)

©Copyright 2008 – 2016 Idea Math

Idea Math  
Internal Use

# Contents

© Copyright 2008 – 2016 Idea Math

<b>Algebra</b>	<b>1</b>
1.1 Algebra practice set 1 . . . . .	1
1.2 Polynomials, roots, and coefficients (part 1) . . . . .	2
1.3 The second look at the AM-GM inequality . . . . .	3
1.4 Algebra practice set 2 . . . . .	4
1.5 Polynomials, roots, and coefficients (part 2) . . . . .	5
1.6 Relations between AM-GM-HM, Cauchy-Schwartz, and Schur . . . . .	6
1.7 Algebra practice set 3 . . . . .	7
1.8 Introduction to functional equations (part 1) . . . . .	8
1.9 Inequality practice set 1 . . . . .	9
1.10 Classification of conic curves . . . . .	10
1.11 Algebra practice set 4 . . . . .	11
1.12 Introduction to functional equations (part 2) . . . . .	12
1.13 Inequality practice set 2 . . . . .	13
1.14 Algebra practice set 5 . . . . .	14
1.15 Properties of polynomials . . . . .	15
1.16 Inequality practice set 3 . . . . .	16
1.17 Algebra practice set 6 . . . . .	17
1.18 Introduction to functional equations (part 3) . . . . .	18
1.19 Inequality practice set 4 . . . . .	19
1.20 Introduction to functional equations (part 4) . . . . .	20
<b>2 Combinatorics</b>	<b>21</b>
2.1 General terminologies in graph theory (part 1) . . . . .	21
2.2 General terminologies in graph theory (part 2) . . . . .	23
2.3 Math reasoning practice set 1 . . . . .	24
2.4 General terminologies in graph theory (part 3) . . . . .	25
2.5 Introduction to Ramsey theory (part 1) . . . . .	27
2.6 Math reasoning practice set 2 . . . . .	28
2.7 Introduction to Ramsey theory (part 2) . . . . .	29
2.8 More on the connectivity of graphs (part 1) . . . . .	30
2.9 Math reasoning practice set 3 . . . . .	31

2.10	More on the connectivity of graphs (part 2)	32
2.11	Eulerian walks and Hamiltonian cycles	34
2.12	Math reasoning practice set 4	36
2.13	Trees (part 1)	37
2.14	Trees (part 2)	38
2.15	Math reasoning practice set 5	39
2.16	Mathematical arguments – the Pigeonhole principle	40
2.17	Math reasoning practice set 6	41
2.18	Mathematical arguments – coloring and assigning weights	42
2.19	Math reasoning practice set 7	43
2.20	Mathematical arguments – mathematical induction	44
2.21	Math reasoning practice set 8	46
2.22	Mathematical arguments – the well ordering principle	47
2.23	Math reasoning practice set 9	48
2.24	Graph theory in action	49
2.25	Math reasoning practice set 10	51