

# Contents

## Part A. Survey articles

<b>1</b>	<b>A rapid introduction to Drinfeld modules, <math>t</math>-modules, and <math>t</math>-motives . . .</b>	<b>3</b>
	<i>by W. Dale Brownawell, Matthew A. Papanikolas</i>	
1.1	Introduction . . . . .	3
1.2	Exponential functions of algebraic groups . . . . .	3
1.3	Drinfeld modules . . . . .	5
1.4	$t$ -Modules . . . . .	11
1.5	$t$ -Motives . . . . .	19
	References . . . . .	28
<b>2</b>	<b>Pink’s theory of Hodge structures and the Hodge conjecture over function fields . . . . .</b>	<b>31</b>
	<i>by Urs Hartl, Ann-Kristin Juschka</i>	
2.1	Introduction . . . . .	31
2.2	Hodge–Pink structures . . . . .	43
2.3	Mixed $A$ -motives . . . . .	49
2.4	Mixed dual $A$ -motives . . . . .	73
2.5	Anderson $A$ -modules . . . . .	94
2.6	Applications . . . . .	155
2.7	$\sigma$ -Bundles . . . . .	158
	References . . . . .	177
<b>3</b>	<b>Local shtukas, Hodge–Pink structures and Galois representations . . .</b>	<b>183</b>
	<i>by Urs Hartl, Wansu Kim</i>	
3.1	Introduction . . . . .	183
3.2	Local shtukas . . . . .	187
3.3	Divisible local Anderson modules . . . . .	191
3.4	Tate modules . . . . .	195
3.5	Hodge–Pink structures . . . . .	209
3.6	Admissibility and weak admissibility . . . . .	222
3.7	Torsion local shtukas and torsion Galois representations . . . . .	230
3.8	Deformation theory of Galois representations . . . . .	245
	References . . . . .	255
<b>4</b>	<b>Frobenius difference equations and difference Galois groups . . . . .</b>	<b>261</b>
	<i>by Chieh-Yu Chang</i>	
4.1	Introduction . . . . .	261
4.2	$t$ -Motivic transcendence theory . . . . .	262
4.3	Carlitz polylogarithms and special $\zeta$ -values . . . . .	268

4.4	Special values of geometric and arithmetic $\Gamma$ -functions . . . . .	274
4.5	Periods and logarithms of Drinfeld modules . . . . .	284
4.6	Transcendence problems with varying constant fields . . . . .	289
	References . . . . .	294
<b>5</b>	<b>An introduction to Mahler's method for transcendence and algebraic independence</b> . . . . .	<b>297</b>
	<i>by Federico Pellarin</i>	
5.1	Introduction . . . . .	297
5.2	Transcendence theory over the base field $\mathbb{Q}$ . . . . .	299
5.3	Transcendence theory in positive characteristic . . . . .	306
5.4	Algebraic independence . . . . .	318
	References . . . . .	346
<b>6</b>	<b>Automata methods in transcendence</b> . . . . .	<b>351</b>
	<i>by Dinesh S. Thakur</i>	
6.1	Introduction . . . . .	351
6.2	Automata: implications, equivalences: definitions and statements . . . . .	352
6.3	Sketches of proofs . . . . .	359
6.4	Applications to function field arithmetic . . . . .	362
6.5	Comparison with other tools . . . . .	364
6.6	Refined transcendence classification based on strength of computers . . . . .	366
6.7	Beyond function field real numbers . . . . .	367
6.8	Strong characteristic dependence for algebraicity and real numbers . . . . .	368
	References . . . . .	370
 <b>Part B. Research articles</b>		
<b>7</b>	<b>Iwasawa theory over function fields</b> . . . . .	<b>375</b>
	<i>by Andrea Bandini, Francesc Bars, and Ignazio Longhi</i>	
7.1	Introduction . . . . .	375
7.2	Control theorems for abelian varieties . . . . .	378
7.3	$\Lambda$ -Modules and Fitting ideals . . . . .	386
7.4	Modular abelian varieties of $GL_2$ -type . . . . .	389
7.5	Class groups . . . . .	392
7.6	Cyclotomy by the Carlitz module . . . . .	404
	References . . . . .	413
<b>8</b>	<b><math>1-t</math>-Motifs</b> . . . . .	<b>417</b>
	<i>by Lenny Taelman</i>	
8.1	Introduction & statement of the main results . . . . .	417
8.2	Duality for torsion modules over $k[[z]]$ . . . . .	419
8.3	Effective $t$ -motifs and abelian $t$ -modules . . . . .	420

8.4	Algebraic theory of $1-t$ -motifs . . . . .	425
8.5	Uniformization and Hodge structures . . . . .	429
8.6	Transcendental theory of $1-t$ -motifs . . . . .	434
	References . . . . .	438
<b>9</b>	<b>Multizeta in function field arithmetic . . . . .</b>	<b>441</b>
	<i>by Dinesh S. Thakur</i>	
9.1	Introduction . . . . .	441
9.2	Multizeta values for function fields: Definitions . . . . .	442
9.3	First kind of relations between multizeta . . . . .	443
9.4	Second kind of relations between multizeta . . . . .	445
9.5	Period interpretation and motivic aspects . . . . .	446
9.6	Updates added on 23 August 2011 . . . . .	448
9.7	Updates added on 5 February 2013 . . . . .	449
9.8	Updates added on 27 April 2015 . . . . .	449
	References . . . . .	450
	Index . . . . .	455