is true  $\alpha \tau_1 \cdots \tau_n = \beta$ .

Text	book	<b>Reading:</b>	Chapters 5, 6,	7	<b>Due Date:</b> Friday, February 5, 2021 by 11:59pm		
Week	Date	Sections from FS2009	Part/ References	Topic/Sections	Notes/Speaker		
Inst	truct	ions.3	Combinatorial	Symbolic methods			
2 3	$U_{21}^{14}$ Uploa	1.4, 1.5, 1.6 ad a copy o 11.1, 11.2, 11.3	Structures fS: Part A.1 A.2 f Xmlef74SSignme Handout #1	Unlabelled structures ent (pdf format) Labelled structures I	to the Crowdmark link you've received via email.		
4 <b>•</b>	Gørre	ctness,	irtey,5 👁 Concisei	ressented presentation	tion are reflected in the grading.		
5● 6	Golla derst	borative d anding & 1 IV.1, IV.2	iscussion parameters cosults. Acknow (self-study)	e assignment in Parameters ledge colleagues Multivariable GFs	encouraged, but the write-up should reflect you own un- a, TA, or other assistance you received.		
7 Qµe	19 estio	IV.3, IV.4 <b>ns</b> IV.5 V.1	Analytic Methods FS: Part B: IV, V, VI Appendix B4 Stapley 99: Ch. 6	Complex Analysis Singularity Analysis			
°1.	Swar	o Puzzle a	rrangements	afid mioves in c	Asst #2 Due cycle notation. The following diagram shows a sequence		
10	<b>of mo</b>	ves that h	ave been applie	d to a scrambling Introduction to Prob.	g <sup>S</sup> Of <sup>A</sup> the tiles in Swap. Mariolys		
11	18 20	IX.1 5 4	<sup>3</sup> 2 <sup>4</sup> 8 <sup>5</sup> 1 <sup>6</sup> 3 <sup>7</sup> 6	${}^{8}7 \xrightarrow{\tau_{1}} 5 2 34$	$4 \stackrel{*}{8} \stackrel{*}{1} \stackrel{*}{3} \stackrel{7}{6} \stackrel{*}{7} \stackrel{\tau_2}{\rightarrow} 1 \stackrel{*}{2} 3 \stackrel{*}{4} \stackrel{*}{8} \stackrel{*}{5} \stackrel{*}{3} \stackrel{7}{6} \stackrel{*}{7}$		
12	23	IX.3	presentations)	$\xrightarrow{\tau_3} 1^2 2^{32}$	4 <sup>4</sup> 8 <sup>5</sup> 5 <sup>6</sup> 3 <sup>7</sup> 7 <sup>8</sup> 6		
	ω th	effollowing	g:	Continuous Limit Laws	Marni		
13	(a) Ex (b) Ex	xpress the xpress eacl	starting position in move $\tau_i$ as a 2-	n coa <b>as cavepennut</b> -cycle.	ation in cycle notation.		
14	(e) Express the whole move sequence $\tau_1 \tau_2 \tau_3$ as a permitted in cycle notation.						
	(d) Express the final position $\beta$ as a permutation in cycle notation and show that the following equation						

2. Decomposing a permutation into 3-cycles. Write the permutation  $\alpha = (1 \ 2)(3 \ 4)$  as a product of 3-cycles.

(Hint: Solve the corresponding Swap puzzle, under the variation where the legal moves are now 3-cycles, and write down the permutations representing your sequence of moves.)

3. **15-Puzzle position into cycle notation.** Express the scrambling of the 15-puzzle as a permutation in cycle form.

$^{1}$ 2	<sup>2</sup> 6	<sup>3</sup> 5	<sup>4</sup> 4
<sup>5</sup> 1	$^{6}15$	7	<sup>8</sup> 14
<sup>9</sup> 8	<sup>10</sup> 9	<sup>11</sup> 7	<sup>12</sup> 3
13	<sup>14</sup> 11	<sup>15</sup> 12	<sup>16</sup> 10

4. 15-Puzzle arrangements from cycle notation. For the permutation  $(1\ 10\ 5\ 15)(2\ 4\ 8)(6\ 7\ 12)$ , draw the corresponding scrambling of the tiles on the 15 puzzle.

(A 15-puzzle templates is available as .png files from the Assignments page.)

- 5. **Oval Track Puzzle move sequence in cycle notation.** For the Oval Track puzzle in the diagram below do the following.
  - (a) Express the position of the puzzle configuration on the left as a permutation  $\beta$  in cycle form.
  - (b) Express the move sequence  $\alpha$  as a permutation in cycle form.
  - (c) Verify that the permutation representing the position on the right is equal to the product of  $\beta$  and  $\alpha$ .



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## 6. For each of the formation is permutations, inalysecle form, write it as a product of 2-cycles. State whether the permutation is composed. Premutation is composed. Handout #1 Asymptotic methods Asymptotic methods

**10**  ${}^{9}(a) (2^{Vl_{4}1}79)(35^{(self-study)}) (35^{(self-study)})$ 

Asst #2 Due Sophie Mariolys (1 2 3 4 5)(6 7 8 9 10)

17. The parity of 15-puzzle scrambles. For each of the following arrangements of the 15-puzzle determine the parity of the corresponding permutations. Sophie



- 8. Show each of the following.
  - (a) The product of two even permutations is an even permutation.
  - (b) The product of two odd permutations is an even permutation.
  - (c) The product of one even permutation and one odd permutation is an odd permutation.
- 9. (a) If α is even, prove that α<sup>-1</sup> is even.
  (b) If α is odd, prove that α<sup>-1</sup> is odd.
  In other words, show that α and α<sup>-1</sup> have the same parity.
- 10. Let  $\alpha, \beta \in S_n$ . Prove that  $\alpha$  and  $\beta^{-1}\alpha\beta$  have the same parity.
- 11. (a) Give an example of an even permutation with even order.(b) Give an example of an odd permutation with even order.(c) Show that a permutation with odd order must be an even permutation.