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Van Kampen ' s

Theorem Problem 1.

Suppose  $G$  and  $H$  are  
nontrivial groups.

Suppose  $x = g h^{-1}$

$\cdot \cdot \cdot g^{-1} h$  lies in the  
center of  $G \times H$ , where  $g$   
 $i \in G$  and  $h i \in H$ . For any

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$G = 1 H$ , we have  $g g$

$$1 h 1 \cdot \cdot \cdot g n h n g$$

$$- 1 h - 1 n g - 1 n$$

$$\cdot \cdot \cdot h - 1 1 g - 1 1 =$$

1. The only way for this to be true for all  $g$  is if  $h = 1$  for all  $i$ .

Van Kampen's

Theorem

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course will primarily use Chapters 0, 1, 2, and 3. Prerequisites. In addition to formal prerequisites, we will use a number of notions and concepts without much explanation.

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# 2 Hatcher, Chap. 0,  
Problem 16.1 Let  $R_1 := M$

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$n, 1 \mathbb{R} = n \sim x =$   
 $(x_k)_{k=1}^n; \mathbb{N}: x_n = 0; \mathbb{R}^n$   
 $, \mathbb{N}^n$ : We define a  
topology on  $\mathbb{R}^n$  by  
declaring a set  $S \subseteq \mathbb{R}^n$   
closed if and only if,  $\forall n$   
 $\in \mathbb{N}, 0$ , the intersection  $S \cap$   
with the finite  
dimensional subspace  $\mathbb{R}^n$   
 $= \{ (x_k)_{k=1}^n; x_k = 0; \forall k$   
 $> n \}$ ; is closed in the  
Euclidean topology of  
 $\mathbb{R}^n$ . For each  $x \in \mathbb{R}^n$  set  
 $j \sim x_j := \sum_{k=0}^{\infty} x_k^2$

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# 1 Hatcher, Chap. 0,

Problem 4.

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are to the 2002 printed

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edition. Chapter 0 Ex.

0.2. Define  $H: (\mathbb{R}^n - \{0\}) \times I \rightarrow \mathbb{R}^n - \{0\}$  by  
 $H(x,t) = (1-t)x + t|x|x$ ,  
 $x \in \mathbb{R}^n - \{0\}$ ,  $t \in I$ . It is  
easily verified that  $H$  is a  
homotopy between the  
identity map and a  
retraction onto  $S^{n-1}$ ,  
i.e. a deformation  
retraction. Ex. 0.3.

Allen Hatcher: Algebraic  
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textbook in algebraic  
topology. What's in the  
Book? To get an idea you  
can look at the Table of  
Contents and the  
Preface.. Printed Version:  
The book was published  
by Cambridge University  
Press in 2002 in both  
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By Lemma 1.15  
(Hatcher), every loop in  
 $X$  based at  $x_0$  is  
homotopic to a product  
of loops, where each loop  
is either contained in  $e$

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nor  $A$ . Since  $n \geq 2$ , a loop contained in  $e$  is nullhomotopic, so every loop in  $X$  is homotopic to a loop in  $A$ . Thus if  $[f] \in \pi_1(X; x_0)$ , there is a loop  $f_0: I \rightarrow A$  such that  $[f_0] = [f]$ . We have  $f_0 \simeq f$ , so  $[f_0] = [f_0] = [f_0] = [f]$ .

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book, published in 2002, is a beginning graduate-level textbook on algebraic topology from a fairly classical point of view. To find out more or to download it in electronic form, follow this link to the download page.

Allen Hatcher's  
Homepage - Cornell  
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Math 634: Algebraic  
Topology I, Fall 2015  
Solutions to Homework  
#3 Exercises from

Hatcher: Chapter 1.2,  
Problems 4, 7, 8, 9, 14,  
15, 21 (Y path-  
connected). 4. If  $X$  is the  
union of  $n$  lines through  
the origin in  $\mathbb{R}^3$ , then  $\mathbb{R}^3$   
or  $X$  admits a deformation  
retraction to the  
complement of  $n$  points  
in  $S^2$ , which is

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Topology to the complement of  $n + 1$  points in  $\mathbb{R}^2$ . This in turn admits a deformation retraction to a wedge of  $n + 1$  circles, so  $\pi_1 \cong \mathbb{Z}^{n+1}$ .

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Allen Hatcher. In most major universities one of the three or four basic first-year graduate

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Topology courses is algebraic topology. This introductory text is suitable for use in a course on the subject or for self-study, featuring broad coverage and a readable exposition, with many examples and exercises. The four main chapters present the basics: fundamental group and covering spaces, homology and

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Topology, higher  
homotopy groups, and  
homotopy theory  
generally.

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and 2 in "Algebraic  
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Group Weeks 7-13:

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Before We Start The

struggle between intuitive  
idea and rigorous ...

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Topology by ...

Text: We will mostly follow chapters 3 and 4 of Algebraic Topology by Allen Hatcher. The book is available for free online at the author's website. as well as in print. Grades: The grade will be based on homework assignments. Homework: A list of the homework problems will be kept on this webpage.

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Topology Allen Hatcher.

Chapter 0 . Exercise 16

The infinite sphere is  
contractible Chapter 2 .

Exercise 1.1 Exhibiting a  
Möbius strip as a quotient  
of a two-simplex

Algebraic Topology

Consider the homotopy

$g_t = f \quad t: S_n - 1 \rightarrow B.$

Then we lift the

homotopy  $g_t$  up to a

homotopy  $\tilde{g}_t$ :

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$S_{n-1} \rightarrow E$  by applying the CHP. The homotopy  $\sim$   $gt$  may be considered as a map  $\tilde{h} : D_n \rightarrow E$ , where the disk  $D_n$  is covered by  $(n-1)$ -spheres as it is shown, see Fig. 9.7 (b), and the map  $h$  on these spheres is given by  $\sim$   $gt$ .

## NOTES ON THE COURSE

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## INTRODUCTION

Most of this book is based on lectures to third-year undergraduate and postgraduate students. It aims to provide a thorough grounding in the more elementary parts of algebraic topology, although



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Homework 2 September

8, 2016 1-6 How many

faces does an  $n$ -simplex

have? Solution: Let  $n$  be

an  $n$ -simplex. Since  $n$  has

$n + 1$  vertices, there are  $n + 1$

1 0-faces of  $n$ . Likewise,  $n$

has  $n + 1$  2 1-faces. In

general, we can say that

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the number of  $(k-1)$ -faces is  $n+1$

$k$ . So, we have  $\sum_{k=1}^{n+1} k$

$n+1$  total faces of  $n$ . 1-8

Triangulation of the

Klein Bottle.  $a_0 = 0$ ,  $a_2 = 1$ ,  $a_3 = 0$

$a_5 = 3$ ,  $a_6 = 3$

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