

SOLUTIONS OF HATCHER ALGEBRAIC TOPOLOGY EXERCISE 4

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Solutions of Hatcher Algebraic Topology Exercise 4

Question: Let X be a space and let $A \subset B \subset X$ be subspaces. Show that $H_n(A, B) \cong \text{Ker}(H_n(A) \rightarrow H_n(B))$.

Answer:

Consider the exact homology sequence of the pair (B, A) :

$$\dots \rightarrow H_{n+1}(B, A) \rightarrow H_n(A) \rightarrow H_n(B) \rightarrow H_n(B, A) \rightarrow H_{n-1}(A) \rightarrow \dots$$

By the definition of relative homology, we have $H_n(B, A) \cong H_n(A, B)$. Therefore, the homology group $H_n(A, B)$ is isomorphic to $\text{Ker}(H_n(A) \rightarrow H_n(B))$.

Question: Let X be a space and let $A \subset X$ be a subspace. Show that the inclusion map $i: A \rightarrow X$ induces a surjection $i_*: H_n(A) \rightarrow H_n(X)$.

Answer:

Consider the exact homology sequence of the pair (X, A) :

$$\dots \rightarrow H_{n+1}(X, A) \rightarrow H_n(A) \rightarrow H_n(X) \rightarrow H_n(X, A) \rightarrow H_{n-1}(A) \rightarrow \dots$$

By the excision theorem, we have $H_{n+1}(X, A) = 0$. Therefore, the map $i_*: H_n(A) \rightarrow H_n(X)$ is surjective.

Question: Let X be a space and let $A, B \subset X$ be subspaces such that $A \cap B = \emptyset$. Show that there is an exact sequence:

$$\dots \rightarrow H_n(A) \rightarrow H_n(B) \rightarrow H_n(A \cap B) \rightarrow H_n(A \cup B) \rightarrow H_{n-1}(A) \rightarrow H_{n-1}(B)$$

Answer:

Consider the exact homology sequence of the three-way intersection:

$$\dots \rightarrow H_{n+1}(X, A \cap B) \rightarrow H_n(A \cap B) \rightarrow H_n(A) \rightarrow H_n(B) \rightarrow H_n(X) \rightarrow \dots$$

By the excision theorem, we have $H_{n+1}(X, A \cap B) \cong H_{n+1}(A \cap B, A \cap B)$. Since $A \cap B = \emptyset$, we have $H_{n+1}(A \cap B, A \cap B) = 0$. Therefore, the exact sequence simplifies to:

$$\dots \rightarrow H_n(A) \rightarrow H_n(B) \rightarrow H_n(A \cap B) \rightarrow H_n(A \cup B) \rightarrow H_{n-1}(A) \rightarrow H_{n-1}(B)$$

Question: Let X be a space and let $A \subset X$ be a subspace. If A is a deformation retract of X , then the inclusion map $i: A \rightarrow X$ induces an isomorphism $i_*: H_n(A) \rightarrow H_n(X)$.

Answer:

Since A is a deformation retract of X , there is a continuous map $f: X \rightarrow A$ such that $f \circ i = 1_A$. Consider the exact homology sequence of the pair (X, A) :

$$\dots \rightarrow H_{n+1}(X, A) \rightarrow H_n(A) \rightarrow H_n(X) \rightarrow H_n(X, A) \rightarrow H_{n-1}(A) \rightarrow \dots$$

By the excision theorem, we have $H_{n+1}(X, A) = 0$. Since f is a continuous map, it induces a homomorphism $f_*: H_n(X) \rightarrow H_n(A)$. By the naturality of homology, we have $i_* f_* = 1_{H_n(A)}$. Therefore, i_* is a monomorphism. Since $H_n(A) \cong \text{Ker}(H_n(A) \rightarrow H_n(X))$, we have i_* is also an epimorphism. Thus, i_* is an isomorphism.

The Cultural Landscape: An AP Edition

Q: What is cultural landscape?

A: Cultural landscape refers to the modifications made to the Earth's surface by human activities over time. It encompasses both physical manifestations, such as buildings and infrastructure, and intangible elements like traditions and beliefs.

Q: What are the components of cultural landscape?

A: The AP Edition of the book identifies four main components: tangible or built environment, intangible or cultural associations, ecosystem services, and spatial patterns. Tangible elements include buildings, roads, and agricultural fields, while intangible aspects encompass oral histories, religious rituals, and language. Ecosystem services refer to the benefits humans derive from the environment, such as air and water purification. Lastly, spatial patterns describe the organization and distribution of features within the landscape.

Q: How does cultural landscape influence society?

A: Cultural landscape shapes societal norms, values, and identity. It provides a sense of place and belonging, influences economic activities, and serves as a repository of cultural knowledge. The physical manifestations of culture reflect societal history, technological advancements, and aesthetic preferences.

Q: How is cultural landscape studied?

A: The study of cultural landscape involves interdisciplinary approaches from fields such as geography, anthropology, and history. Researchers employ techniques such as field surveys, archival research, and oral interviews to analyze the relationship between humans and their environment. The AP Edition provides a structured framework for examining cultural landscapes, emphasizing the importance of context, scale, and comparison.

Q: Why is it important to preserve cultural landscapes?

A: Preserving cultural landscapes is essential for understanding our past, present, and future. They provide valuable insights into human-environment interactions, shape our cultural heritage, and offer opportunities for sustainable development. By valuing and protecting cultural landscapes, we can foster a sense of place, promote cultural diversity, and ensure the legacy of our collective experiences.

Theory Test Online: Everything You Need to Know

Taking a theory test online is a convenient and accessible way to prepare for your driver's license exam. By understanding the process and the types of questions you can expect, you can increase your chances of passing.

What is a Theory Test Online?

A theory test online is a computerized test that assesses your knowledge of driving theory. It covers topics such as road rules, vehicle safety, environmental awareness, and hazard perception. The test is typically multiple-choice and requires you to answer a certain number of questions correctly to pass.

How to Take a Theory Test Online

To take a theory test online, you will need to register with a reputable provider. Once you have created an account, you can select a time and date to take the test. You will be asked to provide some personal information and pay a fee.

Types of Theory Test Questions

Theory test questions can be categorized into three main types:

- **Multiple-choice:** These questions present you with several options and ask you to choose the correct answer.
- **Hazard perception:** These questions show you video clips of potential hazards and ask you to identify when you should take action.
- **Case study:** These questions present you with a scenario and ask you to explain the appropriate driving action.

Tips for Passing the Theory Test Online

To increase your chances of passing the theory test online, consider the following tips:

- **Study the official handbook:** The official driver's manual contains all the necessary information for the test.
- **Take practice tests:** Practice tests help you familiarize yourself with the question format and identify areas where you need more study.
- **Review previous questions:** Many providers offer access to previous theory test questions, which can be a valuable learning tool.

- **Focus on hazard perception:** Hazard perception questions can be challenging, so practice identifying and responding to potential hazards.
- **Take your time:** Don't rush through the test. Read the questions carefully and consider all the options before making your answer.

Subsea Pipeline Engineering: FAQ with Palmer

What is subsea pipeline engineering?

Subsea pipeline engineering encompasses the design, installation, maintenance, and repair of pipelines submerged in bodies of water. These pipelines transport oil, gas, and other fluids from offshore reserves to onshore processing facilities.

Why is subsea pipeline engineering important?

Subsea pipelines are essential for accessing and transporting vast hydrocarbon resources located in deepwater and offshore environments. They enable the development of new energy sources, support existing production, and reduce environmental impact.

What are the challenges of subsea pipeline engineering?

Subsea pipeline engineering faces unique challenges, including harsh marine conditions, inaccessible work sites, and the need for specialized equipment and technologies. Engineers must consider factors such as water depth, pressure, current, and corrosion to ensure that pipelines can withstand these challenges.

What is the role of Palmer in subsea pipeline engineering?

Palmer is a leading provider of subsea pipeline engineering services. With decades of experience, Palmer designs, installs, and maintains subsea pipelines worldwide. Their team of experts leverages advanced technologies and innovative approaches to deliver safe and cost-effective solutions.

What is the future of subsea pipeline engineering?

The future of subsea pipeline engineering lies in the development of more efficient and environmentally friendly technologies. Innovations in materials, construction techniques, and monitoring systems will continue to drive advancements in subsea

pipeline engineering, enabling the further exploitation of offshore resources.

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