Ethereum Basics

1. What is gas in the context of Ethereum?

2. What happens with spare gas if too much gas is provided for a transaction?

3. In contrast to the transaction-based ledger of Bitcoin, Ethereum uses an account-based ledger to maintain the world state. In Bitcoin, double spending attacks are avoided by UTXOs. Once a UTXO is spent (i.e., used as an input), it cannot be spent again, creating a coin ownership chain. How does Ethereum prevent double spending?

4. In Ethereum, while each transaction is explicitly written to the blockchain, messages are only stored "virtually". Explain why messages are not published to the blockchain and how the blockchain could be in the same state among all nodes without writing the messages.

5. Name four reasons why a transaction sent to the Ethereum network might not get mined(included in a block).

6. Name two different ways how a mined transaction can fail.

7. Why does a mined transaction that fails still costs gas?

8. Find the following transaction *0xdc33d512db0730614ad9309075463330ffa73dae318077874e169a814b4f13b40* on `https://etherscan.io/` and answer the questions based on it.
Hint: Use the provided recap slides to inform yourself about EIP-1559 transactions.

   (a) The transaction has paid a 0.001942 ETH transaction fee. Show how this calculation is conducted using the provided data fields.

   (b) The transaction has burnt 0.001935 ETH and saved 0.00086 ETH. Show how these calculations are conducted using the provided data fields.

   (c) The transaction is included in block 16947410, which has a base fee of 30.63 Gwei. The following block has a base fee of 30.31 Gwei. Briefly explain what caused the decrease in the base fee.

9. An Ethereum block header has a more complex structure than a Bitcoin block header due to the advanced world state Ethereum maintains. Name the three Merkle Patricia Trie (MPT) roots contained in an Ethereum block header (skip storage root) and name one use case for each.