Problem 1

Consider a lending pool where one can deposit ETH and borrow USDC (exp. Compound or AAVE). A user deposits 100 ETH and uses those as collateral to borrow USDC. Let the initial price be 2000 USDC for 1 ETH, and the liquidation threshold $l = 0.8$.
The user borrows USDC with the loan to value ratio $\beta = 0.75$. Calculate the liquidation price for this position.

Problem 2

Assume you have with 1 ETH in your wallet. How could you double your exposure to ETH dollar price using a lending market? Current ETH price is p, the liquidation threshold for ETH is l and max loan to value ratio for ETH is β. Provide a step by step instruction and calculate the resulting liquidation price. You may assume that all stablecoins are priced perfectly at $1 and the swap fees are negligible.

Problem 3

Derive the expression for the impermanent loss in a standard Uniswap V2 pool with the constant product rule $XY = K$. For convenience use the notation $\gamma = \frac{p_1}{p_0}$ for the relative price change from p_0 to p_1.

Problem 4

Consider a Uniswap V2 pool with two tokens, ETH and USDC. Let X and Y be the token amounts. The initial price is $p_0 = 2000$ USDC for 1 ETH. Let a trader swap 100 ETH for USDC in the pool, the swap price is p_1.
Let's call $\frac{(p_0 - p_1)}{p_0}$ the price slippage in the pool for this swap. Calculate the token reserves in the pool to keep the slippage below 0.1% for such swap.

Problem 5

Consider a Uniswap V3 liquidity pool with concentrated liquidity and two tokens, ETH and USDC. Let the initial price in the pool be p. Let a liquidity provider deposit the assets into the price range $[p1, p2]$, and let L be the liquidity parameter in the chosed price range. Assume no other liquidity providers in the range. Derive the liquidity provider's position value as a function of p.

Problem 6

Let the liquidity provider have a position in the CFMM pool with the $XY = K$ invariant. Let the pool contain one volatile asset and one stablecoin. Assume that the risky asset follows a geometric brownian motion. Get the expression for the expected impermanent loss. How will the expression change if we use the weighted Balancer-type pool with the $X^\alpha Y^{1-\alpha} = K$ invariant, $\alpha \in (0, 1)$?

Problem 7

Derive the expression for the impermanent loss in a standard CLMM with the $(x + \frac{L}{\sqrt{p_b}})(y + L\sqrt{p_a}) = L^2$ invariant. How does the impermanent loss change with the price range?

Problem 8

Use Etherscan and Curve.fi to locate the stableswap pool 0xdcef968d416a41cdac0ed8702fac8128a64241a2.

- What tokens are traded in the pool?
- What is the TVL, how many tokens of each type are in the pool?
- What is the value of the amplification parameter A?
- What contract calls provide the information about the amplification parameter, virtual price, fee? Hint: use the Read contract feature in Etherscan.
- What is the LP token address?
- Calculate the max amount of tokens of each type one can swap in the pool with the slippage limit 1%. Hint: you can use the Curve.fi interface.