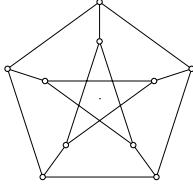# Flows and cycles in graphs – Exercise 1

1. Find a cycle double cover of Petersen graph. Try to find one using just 5 cycles.

2. Let G be a digraph, Γ a group, $f : E(G) \to \Gamma$ any mapping. Let $v_0 \in V(G)$ be any vertex and suppose that Kirchhoff law is satisfied for all vertices in $V(G) \setminus \{v_0\}$. Then f is a flow.

3.

(a) Find the flow polynomial for (an orientation of) K_4. Apply for groups $\mathbb{Z}_4$ and $\mathbb{Z}_2^2$.

(b) **Without using part (a)**, determine the number of NZ $\mathbb{Z}_4$-flows in K_4 (with arbitrary orientation).

(c) **Without using parts (a), (b)**, determine the number of NZ $\mathbb{Z}_2^2$-flows in K_4.

4. Find a NZ Γ-flow for some orientation of the Petersen graph using as small group Γ as possible.