

1. Find the homotopy groups using triangulation method
  - (a)  $\pi_1(T^2)$ ,
  - (b)  $\pi_1(S^1 \times \mathbb{R})$ ,
  - (c)  $\pi_1(S^2)$ ,
  - (d)  $\pi_1(D^2)$ ,
  - (e)  $\pi_1(\mathbb{R}P^2)$ ,
  - (f) the torus with two holes
2. Using Seifert-van Kampen theorem find homotopy groups of
  - (a) the two-sphere  $S^2$ ,
  - (b) the bouquet of  $n$  circles is the topological space obtained by gluing together  $n$  circles at a single common shared point ( $S^1 \wedge S^1$ ),
  - (c) the torus with two holes,
  - (d) the torus with a line segment that touches the torus only at its endpoints
  - (e) Klein bottle.
3. Prove that  $\mathbb{R}$  is a universal covering group of  $S^1$ .