

- 1) Show that “Y” is homotopic to “.”. That is, find a homotopy equivalence from the “Y” given by connecting the points  $(0,-1)$ ,  $(0,0)$ ,  $(1,1)$  and  $(-1,1)$  with three line segments; to the single point  $(0,0)$ .

Find the fundamental groups of the torus, Klein bottle, two-holed torus, punctured torus and thrice punctured sphere; each as a group presentation.

- 2) Find  $\pi_1(\mathbb{T}^2)$ .

- 3) Find  $\pi_1(\mathbb{K}^2)$ .

- 4) Find  $\pi_1(\mathbb{T}^2 \# \mathbb{T}^2)$ .

- 5) Find  $\pi_1(\mathbb{S}^2 - 3\mathbb{D}^2)$ .

- 6) Find  $\pi_1(\mathbb{T}^2 - \mathbb{D}^2)$ .