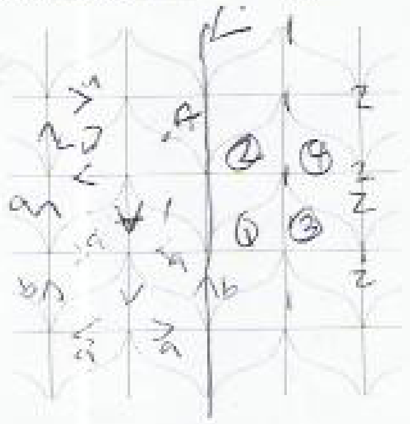
Question 4 (*Unit GE2*)

This question tests your knowledge of various orbits relating to tilings and the
associated orbit diagrams.

Consider the following transitive tiling $\mathcal{T}$.



1

2

a b c
a b c

Note that $\mathcal{T}$ can be formed from $\mathcal{R}_4$ by dividing each tile of $\mathcal{R}_4$ into two by an edge about which there is a rotational symmetry of order 2.

(a) (i) Does $\mathcal{T}$ have any rotational symmetries? Either describe one, or say why none exists. [2]

(ii) Does $\mathcal{T}$ have any indirect symmetries? Either describe one, or say why none exists. [2]

(b) (i) Write down $n_t(\mathcal{T})$, the number of translational tile orbits of $\mathcal{T}$. [1] 2

(ii) Use appropriate theorems from Section 3 of *Unit GE2* to calculate $n_e(\mathcal{T})$ and $n_v(\mathcal{T})$. [6]

(c) (i) Indicate the translational tile and edge orbits on a printout or copy of the magnified portion of $\mathcal{T}$ page 13 of this booklet. Place *circled* numbers at the centres of the tiles to indicate which orbit they belong to, and *uncircled* numbers near the edges to indicate the translational edge orbits. [3]

(ii) Draw the tile–edge diagram for $\mathcal{T}$. [2]

(iii) Explain briefly why the vertex–edge diagram has the same number of lines coming from each edge dot, and explain why the edge dots are of two different types. [2]

(d) (i) Using the magnified portion of one tile of $\mathcal{T}$ on page 13 of this booklet, construct the edge side orbits of $\mathcal{T}$ under the action of the *full* symmetry group $\Gamma(\mathcal{T})$. [4]

(ii) Find the incidence symbol of $\mathcal{T}$, and hence its IH number. [3]

Remember to submit page 13 of this booklet, or a copy of it, with your assignment.

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