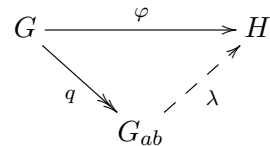


**MATH 651
HOMEWORK IX
SPRING 2013**

Problem 1. (Universal property of abelianization) For any group G , let $G_{ab} = G/[G, G]$ be the abelianization. Show that if $\varphi : G \rightarrow H$ is any homomorphism and H is abelian, then there is a unique homomorphism λ such that $\lambda \circ q = \varphi$.



Problem 2. In the following examples, compute the euler characteristic and determine the surface type. (Be careful—don't assume that these have a single 0-cell).

- (a) X_1 has three 1-cells: a , b , and c ; and a single 2-cell attached by $abacb^{-1}c^{-1}$.
- (b) X_2 has three 1-cells: a , b , and c ; and a single 2-cell attached by $abca^{-1}b^{-1}c^{-1}$.
- (c) X_3 has four 1-cells: a , b , c , and d ; and a single 2-cell attached by $abacdbd^{-1}c$.
- (d) X_3 has four 1-cells: a , b , c , and d ; and a single 2-cell attached by $abcdad^{-1}cb^{-1}$.
- (e) X_4 has six 1-cells: a , b , c , d , e , and f ; and four 2-cells attached by abc , bde , $c^{-1}df$, and $e^{-1}fa$.

Problem 3. Show directly that your answer for problem 2(b) is correct by cutting-and-pasting.