1. Let \((X,T)\) be a topological space, let \(Y\) be a set, and let \(f\) be a function that maps \(X\) onto \(Y\). Show that the quotient topology on \(Y\) induced by \(f\) is a topology on \(Y\).

2. Let \((\mathbb{R},T)\) be the reals with the finite complement topology. Show that \((\mathbb{R},T)\) is separable and not first countable.

3. Show that the countable product of second countable spaces is second countable.

4. Let \(p\) be a cut point of a connected space \(X\) and suppose \(A\) and \(B\) form a separation of \(X \setminus \{p\}\). Show that the union of \(A\) and \(p\) is connected.

5. Show that the intersection of any family of compact subsets of a Hausdorff space is compact.

6. Show that every subspace of a completely regular space is completely regular.

7. Show that if \(X\) is \(T_3\) and second countable then \(X\) can be embedded in the countable product of the unit interval with itself.

8. Let \(h : (X,x_0) \to (Y,y_0)\) be a map. Show that \(h\) induces a homomorphism \(h_*\) on the fundamental groups.

9. Let \(X\) be a locally compact space, let \(Y\) be a space, and let \(f : X \to Y\) be an open continuous function from \(X\) onto \(Y\). Show that \(Y\) is locally compact.
10. Shown is a knot $K$ that bounds a surface $S$. (a) The surface $S$ is obtained by cutting holes in a closed surface $S'$. Use the classification of surfaces to classify $S'$. (b) Give a presentation for the fundamental group of the complement of $K$ in $R^3$. 