# Tutorial 12
## Advanced Graph Theory
## Planarity

$13^{th}$ November 2014

1. (Contd from Tut. 11)
   Edges in a plane graph G form a cycle in G if and only if the corresponding dual edges form a bond in $G^*$.

   Using this result, prove that a set of edges in a connected plane graph $G$ forms a spanning tree of $G$ if and only if the duals of the remaining edges form a spanning tree of $G^*$.

2. Prove that every 3-connected graph with at least six vertices that contains a subdivision of $K_5$ also contains a subdivision of $K_{3,3}$.

3. Let $H$ be a graph with maximum degree at most 3. Prove that a graph G contains a subdivision of $H$ if and only if $G$ contains a subgraph contractible to $H$.