University of Toronto

Department of Computer & Mathematical Sciences

MATC32: Graph theory and applications

Things you should know for the midterm

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this document contains a detailed list of the things you should know in order to prepare for the midterm

Week 1:

You should know the problem of Königsberg,as well as know its proof (1.2.26)

you should know the definition of a morphism (more general than the book) and be able to recognize morphisms and isomorphisms in particular (1.1.20)

Week 2:

- You should know the terminology we introduced in §1.1-2: graph, subgraph, bipartite, chromatic number, path, connected,complement, self-complementary, walk, cycle etc...
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- you should know what an equivalence relation is, know how to check whether a relation is an equivalence and how to describe classes.
- You should know the results from §1.2 the we proved: edge-cut vs cycle (1.2.14), Konig's theorem on bipartite graphs (1.2.15-18)..

Week 3

- You should know what a network is as well as the major concepts associated to a network: capacity, flow, cut avoidance, saturatedness.. You should know and understand the min-cut/max-flow theorem (4.3.1-11-extra notes)
- You should know what the Petersen graph is and be able to work with it (1.1.36-assigment 1)

Week 4

- You should be able to understand the different steps used in the proof of the min-cut/max-flow theorem (extra notes): starting with the flow-capacity inequality, understanding when this becomes an equality, which in turn leads us to define the residual network and consider paths. You should know how a path in the residual network increases the flow and how to deduce the Ford-Fulkerton algorithm from this idea.
- You should be able to make the required computation related to networks and this algorithm (as well as everything related to it) in practice (assignment 2)

Week 5

- You should understand how the min-cut/max flow theorem can be applied. In particular to yield the König theorem on maximal matchings and by extension Hall's marriage theorem. (extra notes)
- You should be able to understand how this leads to Hall's theorem on perfect matchings (extra notes)
- you should be able to translate problems into König's or Hall's result using graph theory and subsequently solve those problems (assigment 2)

Week 6

- You should know the necessary definitions needed to understand Menger's theorem: k-connectedness, disjoint paths etc..
- you should understand how the min-cut/max-flow theorem is used to prove Menger's theorem
- you should be able to apply this theorem in practical applications

Some general comments

- extra notes refers to the appropriate notes found on each lecture page
- If you need to understand *understand* a proof, that does not mean you will be asked to reproduce it, rather you may need to understand the technique in order to solve problems
- You will be asked to prove things yourself however. This will usually be easily solved through a good grasp of the definitions
- you should be able to apply this theorem in practical applications