Syllabus for Graph Theory. (Math 115) A). WINTER quarter 2016. Prof. Richard Montgomery
web site: http://people.ucsc.edu/ rmont/classes/GraphTheory

TEXTS. Algebraic Graph Theory, Biggs – our main text.
Graph Theory , An Introductory Text, Bollabas. - listed as official text.
Graph Theory with Applications, Bondy and Murty (available on line)
Papers re google pageranker, Perron-Frobenius ...

Your grade will be based on :
HOMEWORK plus CLASS PRESENTATIONS: 40 %
MID TERM / Quiz(es) 30 %
TAKE HOME FINAL 30 %

Calendar.
1st day of class: Jan 4. Monday.
last day of class: March 11 Friday
final exam: March 16, 8-11 AM
HOLIDAYS: Jan 18 (Mon): M L King Day; Feb 15: (Mon) President's Day

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Lecture schedule, **Tentative!**

Week 1: **Examples.** Trees. Cyclic graphs. Complete graphs. Skeleton of a platonic solid. Maps. The internet. Graph paper. The Cayley Graph of a discrete group. **Problems.** The traveling salesman problem. The Königsberg bridge problem. The four-color problem.. The page ranking problem. **Definitions.** Vertices, Edges. Degree. Connectedness. Tree. Spanning tree. k -regular. Hamiltonian circuit. Isomorphisms between graphs. Adjacency matrix. Directed graphs. **Geometry** A graph as a metric space. Paths. Distance. Diameter. Girth.

Week 2. Counting trees. From the MAA article. Time permitting: tree number, from Biggs.

Week 3. Google Page Maker. From Notices article; Brinn article; as example of a Markov chain

Week 4. More deeply into the Linear algebra implicit to a graph. Edge space. Vertex space. Adjacency matrix. [Biggs; 2a, 2d, 2h] . Incidence matrix and its transpose, the differential on the the graph. The Laplacian $d^*d = DD^T$ on a graph. Geometric meaning of cycles , of cuts. The Cycle space and Cut space as complementary subspaces of the edge space. Using a spanning tree to make bases by adding or subtracting edges Biggs Thm 4.5: Γ connected. $Ker(D) = im(d)^\perp$ = Cycle subspace. $(ker(D))^\perp = im(d)$ = cut subspace.

Week 5: Re-assess. Mid term. Where are we?

Week 6. Cayley graphs. Growth of graphs. Polynomial vs exponential growth.

Week 7. Planarity. Euler formula. Kuratowski theorem. Duality.

Week 8 : EITHER: Examples and definitions of expander graphs. Small-worlds graphs. Similarities and differences.... OR NP completeness, traveling salesman.

Week 9-10. (?) More topology associated to graphs. Genus of a graph.

MISC TOPICS I aim to cover, not sure when: Every graph can be embedded in space. The chromatic polynomial.Automorphisms of graphs. Polya's theorem, , particularly as illustrated by Example 5, on the penultimate page of Bollabas.