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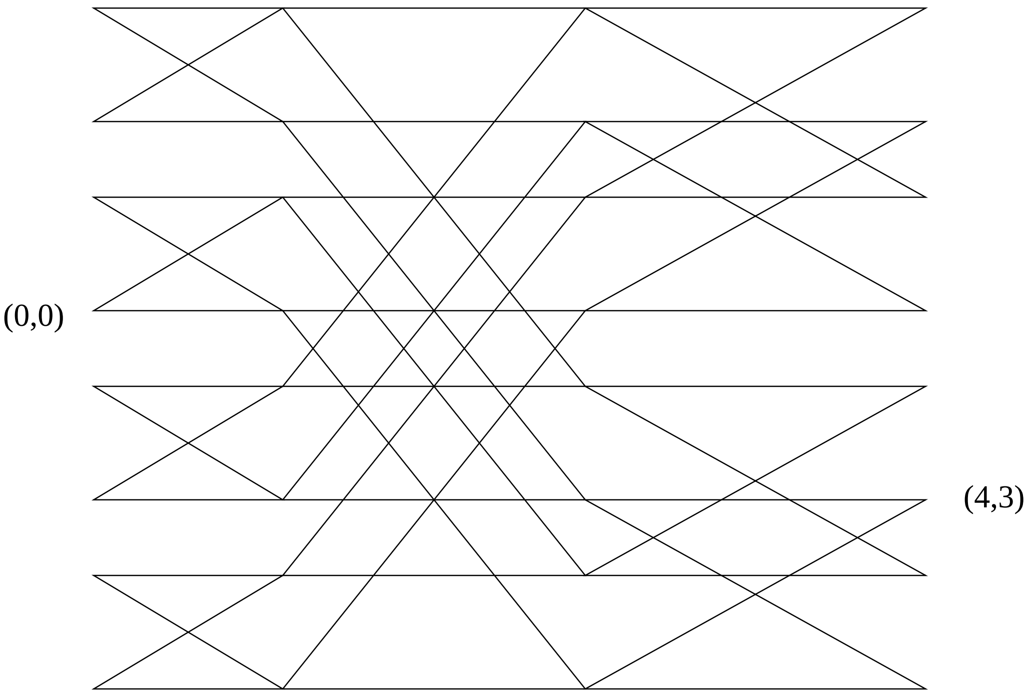
50 marks **CS 408 Quiz 1** **9:30-10:30, 28/1/10**

Write your roll number on the question paper, write on it the answer to problem 1, and submit it along with your answer paper.

Problem 1:[10 marks] The graph below is a redrawing of a Butterfly which was originally numbered in the standard manner. Only two node numbers are shown, i.e. nodes (0,0) and (4,3).

(a) Using the numbers given, it is possible to uniquely identify the numbers of some other nodes. write down the numbers of these nodes on the picture.

(b) Show on the picture the nodes which possibly could have the number (5,1).



Problem 2: Let C_n denote the cycle on n vertices, and P_n the path on n vertices.

(a)[5 marks] Draw $C_4 \Box P_3$.

(b)[15 marks] Give a lower bound on the bisection width of C_n by embedding the complete directed graph on n vertices. Other methods will receive no credit. Be sure to clearly describe how the edges of the complete graph are embedded and what the maximum congestion is.

Problem 3: The cube connected cycles network CCC(n) on $n2^n$ nodes is defined as follows. Each vertex is numbered (x, y), where $0 \leq x < n$, and $0 \leq y < 2^n$. Vertex (x, y) connects to vertex $(x + 1 \bmod n, y)$ and $(x - 1 \bmod n, y)$ using edges called "cycle edges", and to vertex $(x, y \oplus 2^x)$ using edges called "cube edges".

(a)[12 marks] For the case $n = 2^k$ show that CCC(n) is a subgraph of the hypercube Q_{n+k}.

(b)[8 marks] What is the diameter of CCC(n)? Prove your answer.