1. Consider the following graph

(a) Apply LND to partition the graph into two parts. Start at the indicated point in the
drawing on the left. (10 points)

(b) Refine the partition using KL-refinement (right drawing). (10 points)

2. Consider the following graph

Apply KL/FM-refinement by annotating the gain/loss information at each vertex and chang-
ing the partition accordingly step-by-step. In each step you can move two vertices in opposite
directions to preserve the balance constraint. It will take three steps to obtain a edge-cut of

3. Draw and annotate each next step (on the next page). (15 points)
3. Consider the old partition

and the improved new partition after repartitioning from scratch

(a) Determine the similarity matrix. (10 points)
(b) Remap the new subdomains to obtain the scratch-remap partitioned graph. (5 points)
4. Consider the following program fragment

```plaintext
DO I = 1, N
  S1:  C(I) = A(I-1) + B(I)
  S2:  B(I+1) = B(I) + E(I)
  S3:  D(I) = 2*A(I-1)
  S4:  A(I) = B(I)/C(I)
ENDDO
```

(a) Find the flow dependences (use any fast or intuitive method of your choice). Note that there are six dependence pairs formed by array accesses to check, e.g. one such pair is a set of A(I) in S4 which has a use in S3, and so on. (10 points)

(b) Construct the dependence graph for the flow dependences between statements. (5 points)

(c) Determine the acyclic condensation of the graph. (5 points)

(d) Apply loop fission. (10 points)

(e) Which of the resulting loops can and which cannot be vectorized? Why? (5 points)
5. Consider the program fragment

\[
\text{DO } \text{i} = 1, 10 \\
S_1: \quad A(2^i) = A(i-1) + B(i) \\
\text{ENDDO}
\]

(a) Write down the system of inequalities that describes the flow dependence on $S_1$, the dependence equation, and loop constraints. (10 points)

(b) Put the system in matrix form $A I \leq b$. (5 points)