3.3 *Benefit-cost analysis.* Assume that the cost of conducting a quiescent current (I_{DDQ}) test, which measures the steady-state chip current for a few selected vectors (see Chapter 13), is 10% of the per chip cost of burn-in. I_{DDQ} test is non-functional and results in yield loss due to the rejection of some good chips. Suppose that your experimental data shows that when you lower the current threshold to a level where all burn-in failures are rejected by the I_{DDQ} test, an additional 10% of good chips (that pass burn-in) also fail. Examine the following schemes:

(a) *Complete elimination of burn-in:* Show that this scheme is beneficial for chips whose total cost is less than ten times the burn-in cost when the burn-in yield is 90%.

(b) *Apply burn-in test only to chips that fail I_{DDQ} test:* Show that this procedure will be beneficial as long as the burn-in yield is greater than 11.1%.

3.4 *Yield and cost.* Show that for a fractional increase Δ in the area A of a VLSI chip when hardware for design for testability is added, the cost increase is given by

$$\left[(1+\Delta)\left(1+\frac{Ad\Delta}{\alpha+Ad}\right)^{\alpha}-1\right]\times 100 \;\; percent$$

where d is the defect density and α is the defect clustering parameter. Calculate the percentage cost increase if the original chip area is 1 cm^2, $d = 1.25\ defects/cm^2$, $\alpha = 0.5$, and the area overhead is 10%, i.e., $\Delta = 0.1$.

3.5 *Defect level and fault coverage.* Show that for a clustered fault distribution, if the required defect level is DL, then the fault coverage of tests should be

$$T = \frac{(\beta + Af)(1-DL)^{1/\beta} - \beta}{Af} \times 100 \;\; percent$$

where f is fault density, β is fault clustering parameter, and A is chip area.

3.6 *Defect level and fault coverage.* Using test data analysis a chip production process has been characterized with fault density, $f = 1.45$ faults/sq. cm, and fault clustering parameter, $\beta = 0.11$. Given that the fault coverage of tests is 95%, calculate the defect level for a chip of 1 sq. cm area. What should the fault coverage be if the required defect level is: (a) $1,000$ *ppm*, and (b) 500 *ppm*.

3.7 *Defect level.* Show that for an unclustered distribution of faults, as $\beta \to \infty$, the defect level is given by

$$DL(T) = 1 - Y^{1-T}$$

Note: This expression was first derived by Williams and Brown [725].