

## Problem 3

Associative is very fast but is complex and costly.

Direct-mapped is simpler and cheaper but performance may suffer under certain patterns of memory reference.

Set-associative compromises between the other two by having small amounts of associative memory to determine which one of a set of cache blocks a memory reference may be in. This reduces cost and means that multiple hits on the same cache block from different memory blocks can be handled efficiently.

## Problem 4

Write-through does all writes to cache and main memory so memory is always up to date. Writeback

does all writes to cache but only updates main memory if a cache block needs to be replaced.

## Problem 5

15% writes requiring access to main memory

85% x 95% are reads from cache

85% x 5% are reads from main memory

therefore average =  $(0.15 \times 15\text{ns}) + (0.85 \times 0.95 \times 4\text{ns}) + (0.85 \times 0.05 \times 15\text{ns}) = 6.1175\text{ns}$

## Problem 6

Initially:

A = 0; B = 1; C = 2; D = 3

Block E referenced:

E = 3; B = 0; C = 1; D = 2

Block B referenced:

E = 2; B = 3; C = 0; D = 1

Block E referenced:

E = 3; B = 2; C = 0; D = 1

Block D referenced:

E = 2; B = 1; C = 0; D = 3

Block A referenced:

E = 1; B = 0; A = 3; D = 2

Block E referenced:

E = 3; B = 0; A = 2; D = 1

Note: reference to figure 6.17 in the question is accidental and should be ignored.