1.

a)

Given size of memory = 2^{32} words

Cache block size = 32 words = 2^5 words

Number of blocks in the main memory = size of memory / size of cache block

Therefore, Total number of blocks in the main memory = $2^{32} / 2^5 = \mathbf{2^{27}}$.

b)

Given Cache of blocks = 1024 = 2^{10}

Therefore, 10 bits are required in the block field.

Cache block size = 2^5.

Therefore, 5 bits are required in the offset field.

Tag field = 32 - 10 - 5 = 17 bits.

Tag	Block	Offset
17	10	5

c)

Memory reference = $000063FA_{16}$

Converting it to binary = 00000000000000000 **"1100011111"** 11010_2

Tag = $00000000000000000_2 = 0_{10}$

Block = $\mathbf{1100011111_2 = 799_{10}}$

Offset = $11010_2 = 26_{10}$

Therefore, memory reference $000063FA_{16}$ maps to ***block number 799.***

2.

a.

- If the number of address bits are n then, the size of the cache is 2^n words.

Since, the size of the given cache is 2^{16} words, therefore the number of required address bits is 16.

- Since, the memory is two-way set associative, therefore each set contains two blocks.

The cache contains 32 blocks, therefore total sets required as follows:

$$\text{Total Number of sets required} = \frac{\text{Number of blocks}}{\text{Associativity}}$$
$$= \frac{32}{2}$$
$$= 16$$
$$= 2^4 \text{ sets}$$

Therefore, the number of set bits required are 4.

- Each block contains 8 words, that is 2^3 words, therefore 3 bits are required for the word field.
- The remaining bits are required for the tag field. Therefore, the number of bits in the tag field are calculated as follows:

$$\text{Number of bits in the tag field} = \text{Total Number of address bits} - \text{number of set bits} - \text{number of word bits}$$
$$= 16\text{-}4\text{-}3$$
$$= 9 \text{ bits}$$

Therefore, the number of bits in the different fields are as follows:

- **Tag field: 9 bits**
- **Set field: 4 bits**
- **Word field: 3 bits**

b.

- If the number of address bits are n then, the size of the cache is 2^n words.

Since, the size of the given cache is 2^{16} words, therefore the number of required address bits is 16.

- Since, the memory is four-way set associative, therefore each set contains four blocks.

The cache contains 32 blocks, therefore total sets required are as follows:

$$\text{Total Number of sets required} = \frac{\text{Number of blocks}}{\text{Associativity}}$$
$$= \frac{32}{4}$$
$$= 8$$
$$= 2^3 \text{ sets}$$

Therefore, the number of set bits required are 3.

- Each block contains 8 words, that is 2^3 words, therefore 3 bits are required for the word field.
- The remaining bits are required for the tag field. Therefore, the number of bits in the tag field are calculated as follows:

$$\text{Number of bits in the tag field} = \text{Total Number of address bits} - \text{number of set bits} - \text{number of word bits}$$
$$= 16\text{-}3\text{-}3$$
$$= 10 \text{ bits}$$

Therefore, the number of bits in the different fields are as follows:

- **Tag field: 10 bits**
- **Set field: 3 bits**
- **Word field: 3 bits**

3) a) tag = 8
block = 11
offset = 5

b) tag = 19 for fully associative, no block mapping
~~block = 5~~
offset = ~~0~~ 5

c) tag = 10
~~block = 9~~ x set = 9
offset = 5

4) a) tag = 9
block = 3
offset = 3