1) CNN ARCHITECTURE
   i) Input Image: 224 × 224 × 3 (H×W×D)
   ii) Convolutional Layer
          No of filters : 32
          Filter Size : 3×3
          Stride : 1
          Padding : 1
   iii) Max Pooling Layer
          Pool Size : 2×2
          Stride : 2
   iv) Convolutional Layer
          No of filters : 64
          Filter Size : 3×3
          Stride : 1
          Padding : 1

   v) Max Pooling layer :
          Pool Size : 2×2
          Stride : 2

   vi) Fully Connected (Dense) Layer
          No of Neurons : 128
   vii) Output Layer (Classification)
          No of classes : 10

   Now, Calculate the output size and no of Parameters
   for each layer.

i) Input Image: 224 × 224 × 3
ii) CL-1

    Parameters per Filter = (filter height × filter width × input depth) + 1
    = (3×3×

⟹ $W_{out} = \dfrac{W_{in} + 2p - f}{s} + 1$ = $\dfrac{224 + 2×1 - 3}{1} + 1$

    = 224 + 2 - 3 + 1 = 224

$$W_{out} = 224$$

$$h_{out} = \frac{h_{in} + 2p - f + 1}{s}$$

$$= \frac{224 + 2 - 3 + 1}{1}$$

$$= 224$$

$$d_{out} = 32$$

$\Rightarrow$ Output Size $= 224 \times 224 \times 32$

$\Rightarrow$ No of Parameters Calculation:

Parameters per filter $= ($ filter Height $\times$ filter width $\times$ Input depth $) + 1$

$$= (3 \times 3 \times 3) + 1$$

$$= 28$$

Total parameters $=$ parameters per filter $\times$ no of filters

$$= 28 \times 32$$

$$= 896.$$

iii) MPL-1

Output Size calculation

$$W_{out} = \frac{W_{in} - f}{s} + 1$$

$$= \frac{224 - 2}{2} + 1 = \frac{222}{2} + 1$$

$$= 112$$

Another formula

$$h_{out} = \boxed{(h_{in} / \text{pool size})} = \frac{224}{2} = 112$$

$$d_{out} = d_{in} = 32$$

output size: $112 \times 112 \times 32$
No parameters in Pooling layer.

iv) CL-2
output Size

$$W_{out} = \frac{W_{in} + 2P - F + 1}{S}$$

$$= \frac{112 + 2 - 3 + 1}{1}$$

$$= 112$$

$d_{out} = $ No of filters $= 64$

Output Size: $112 \times 112 \times 64$

parameters per filter $= (3 \times 3 \times 32) + 1$

$$= 289$$

Total parameters $= 289 \times 64$

$$= 18496$$

v) MPL-2
o/p Size

$$W_{out} = \frac{W_{in}}{pool\ size}$$

$$= 112/2$$

$$= 56$$

$d_{out} = d_{in} = 64$

Output Size: $56 \times 56 \times 64$

vi) Fully Connected Layers
No of parameters $= ($ I/p neurons $\times$ o/p classes $) +$ o/p neuron

Neurons

$$= (56 \times 56 \times 128) + 128$$

$$= 7296$$

vi) Output Layers
No of Parameters $= (128 \times 10) + 10$

$$= 1290.$$

2.) Given an input image with dimensions $224 \times 224 \times 3$ $(H \times W \times c)$ a convolutional layer with the following parameters:

No. of filters: 32
Filter size : 5×5
Stride : 2
Padding : 1

Calculate output size and no of parameters.

Formula:

Output width $w_{out} = \dfrac{(W_{in} + 2p - f)}{2} + 1$

Output height $h_{out} = \dfrac{(h_{in} + 2p - f)}{S} + 1$

d_{out} = No of filters

$w_{out} = \dfrac{224 + 2 * 1 - 5}{2} + 1$

$= \dfrac{224 - 3}{2} + 1$

$= 112$

Output Size $= 112 \times 112 \times 32$

Parameters per filter $= \dfrac{(\text{filter width} \times \text{filter height} \times \text{Input depth})}{+1}$
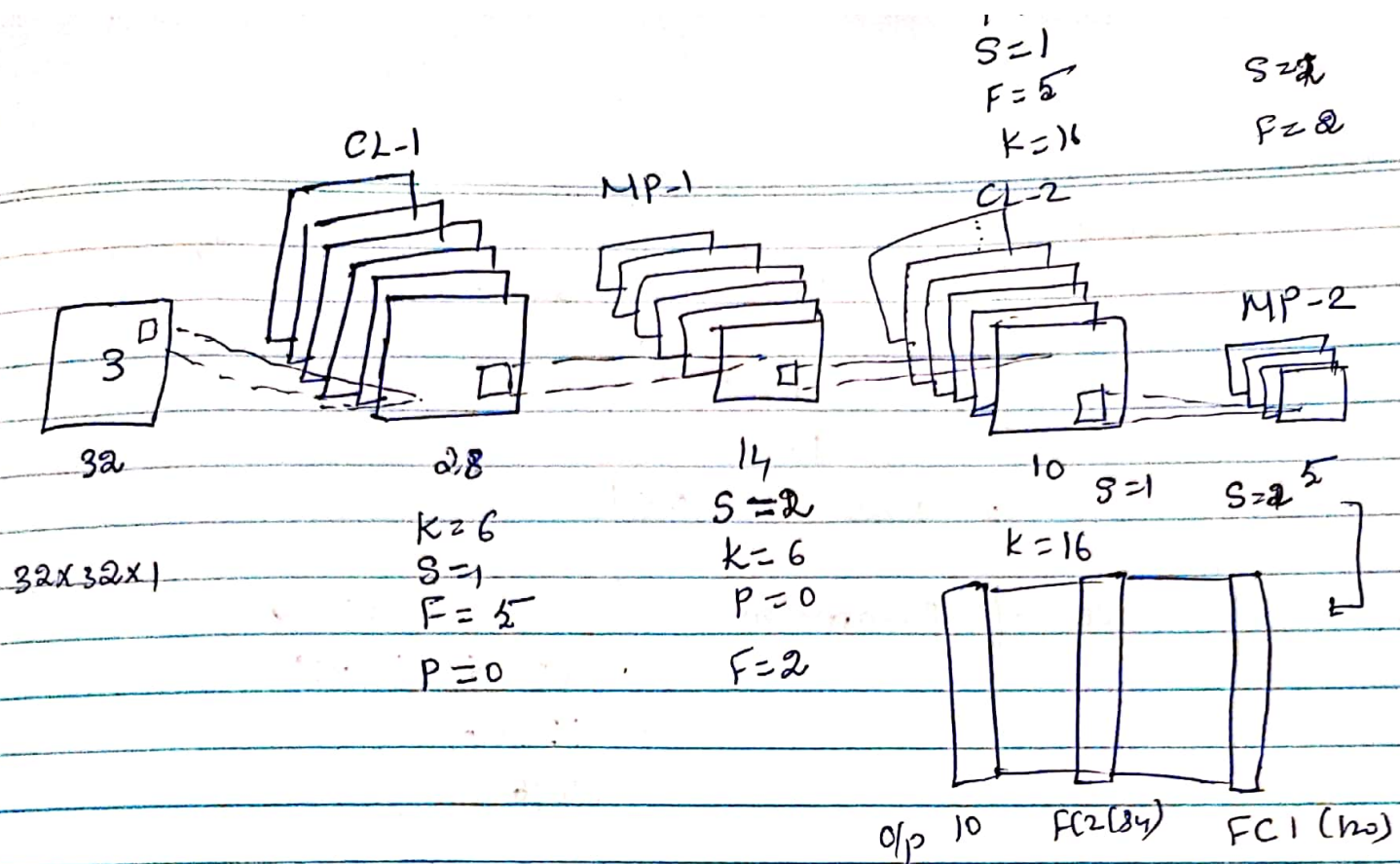
$= (5 \times 5 \times 3) + 1$

$= 76$

Total no of parameters $= 76 \times 32$

$= 2432$

3)

CL-1

MP-1

CL-2

$$S=1$$
$$F=5$$
$$K=16$$

$$S=2$$
$$F=2$$

MP-2

3

32

32×32×1

28

$$K=6$$
$$S=1$$
$$F=5$$
$$P=0$$

14

$$S=2$$
$$K=6$$
$$P=0$$
$$F=2$$

10

$$S=1$$
$$K=16$$

$$S=2$$ 5

O/p 10   FC2 (84)   FC1 (120)

CL-1

$$W_{out} = \frac{32 + 2 \times 0 - 5}{1} + 1$$

$$= 32 - 5 + 1$$

$$= 28$$

output size: 28×28×6

No of Parameter = $\left[\left(\underset{\text{filter size}}{5} \times 5 \times \underset{\text{depth}}{1} \right) + 1 \right] \times \underset{\text{no of filter}}{6}$

$$= 26 \times 6$$

$$= 156$$

MP-1

$$W_{out} = \frac{28 - 2}{2} + 1 = \frac{26}{2} + 1 = 14$$

O/p Size = 14×14×6

CL-2

$$W_{out} = \frac{14 + 2 \times 0 - 5}{1} + 1$$

$$= 14 - 5 + 1$$

$$= 10$$

O/p size $= 10 \times 10 \times 16$

No of parameters $= ((5 \times 5 \times 6) + 1) \times 16$

$$= (25 \times 6) + 1 \quad \times 16$$

$$= 151 \times 16$$

$$= 2416$$

MPL-2

$$W_{out} = \left(\frac{10 - 2}{2}\right) + 1$$

$$= 5$$

O/p Size $= 5 \times 5 \times 16$

FCL-1

No of Parameters $=$ (i/p Neurons $\times$ O/p neurons) $+$ O/p neuron

$$= (5 \times 5 \times 16 \times 120) + 120$$

$$= 48120$$

FCL-2

No of Parameters $= (120 \times 84) + 84 = 10164$

O/p Layer

No of parameters $= (84 \times 10) + 10 = 850$