Student name:
Student number:

1. An image f(x,y) has the following 1 level orthonormal Haar wavelet transform.

20	10	16	7
-10	5	4	3
17	6	3	-1
-2	0	2	0

You are asked to apply EZW coding in compressing the image under the following assumptions

- We have a budget of 35 bits.
- We can send the initial threshold value T_0 separately without effecting the bit budget
- We use the following codes

Zerotree root	zr	00
Significant positive	sp	11
Significant negative	sn	~~01~~ 10
Isolated zero	iz	~~10~~ 01

Show all the required steps of the EZW coding and the final transmitted bitstream. (3 points)

2. Continuing question 1, calculate and compare the original and the 16 bit reconstructed images (3 points)
3. For the wavelet transform of question 1, allocate bits to the 4 sub-bands in an optimum way so that the overall bit count is Rc=1 bit/pixel. (3 points)
4. What are some of the differences between the H.261 and H.263 Video standards? (1 point)
5. What forms of redundancies are explored (removed) in most video compression standards?. (1 point)
6. In a 5 level 2-D Wavelet transform NxN what is the size (resolution) of the largest sub-band and what is the size (resolution of the smallest sub-band? What is the overall number of sub-bands? (1 point)
7. What is asymmetrical coding in video encoding? Name at least one asymmetrical encoder and one symmetrical encoder. (1 point)
8. What is the number of bits per second required by a typical colour video application? Please derive result explicitly. (2 points)

Useful formulas: $A = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & -1 \end{bmatrix}$, $b_k = R_c + \log_2 \frac{w_k \sigma_k^2}{\prod_{i=1}^{M} (w_k \sigma_k^2)^{a_k}}$