

Electrical and Computer Engineering Workbook

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1.2 Reading a Power Bill

Examine the sample bill from PEPCO, which is attached to this handout.

Things to note:

- The generation, transmission and distribution services have separate charges, itemized under “Account Details”. **Generation** refers to the operation of the power plants that convert heat energy from a variety of fuels, or the potential energy of water contained in dams, or nuclear energy in nuclear plants to electrical energy. **Transmission** refers to the operation of the large-scale electrical network over large distances to carry energy at very high voltages from the generators to distribution centers. **Distribution** refers to the operation of distribution centers at city and district and street level, with transformers reducing the hundreds of thousands of volts used in transmission lines to household levels.
- The bill notes that summer rates are in effect. The consumer has used 1410 kWh of energy for this billing period. The Distribution services have a flat rate of 3.112 cents per kWh, listed under “Energy Charge”. The Generation services have a rate of 5.55 cents per kWh for the first 800 kWh of energy, and again 5.55 cents per kWh for the remaining 610 kWh. These two rates might be different for non-summer rates. The Transmission services have a rate of 0.514 cents per kWh for the first 800 kWh, and the same rate for the remaining 610 kWh. These might also be different for non-summer rates. The total net charge comes up to something close to 8.6 cents per kWh, which we rounded off to 9 cents for the questions in the previous section.
- The additional taxes and surcharges will vary between states, counties, and consumers.
- The energy usage history is a useful tool. For example, note that the usage falls during winter months and rises dramatically for summer months—this is probably because of the air conditioning system, which usually uses the largest amount of power among all household electrical systems. By examining the bill, the consumer may be able to pinpoint what appliances or activities are using the most amount of energy and think about ways of reducing the usage.

2 Digital-to-Analog Conversion Worksheet

Using the timescale of the empty graphs provided, convert the given sequences of three-bit digital data to analog waveforms. Comment on the differences of the resulting waveforms.

Example

Sequence: 011 101 110 111 110 101 011 001 000 000 000 001 011 101 110 111 110 101 011

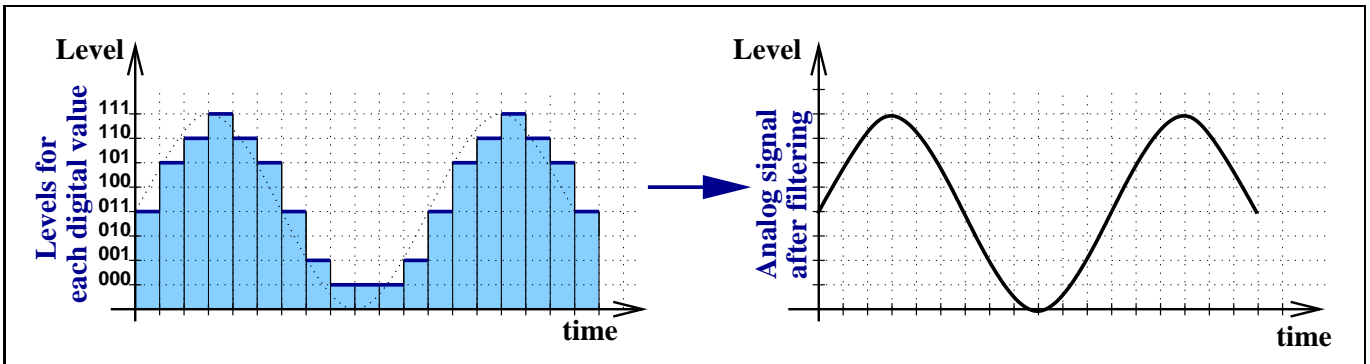
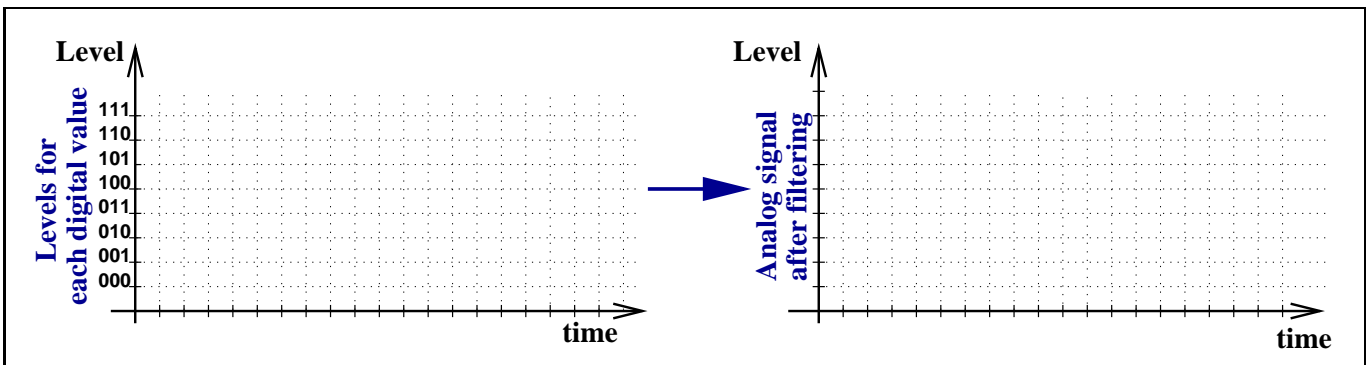
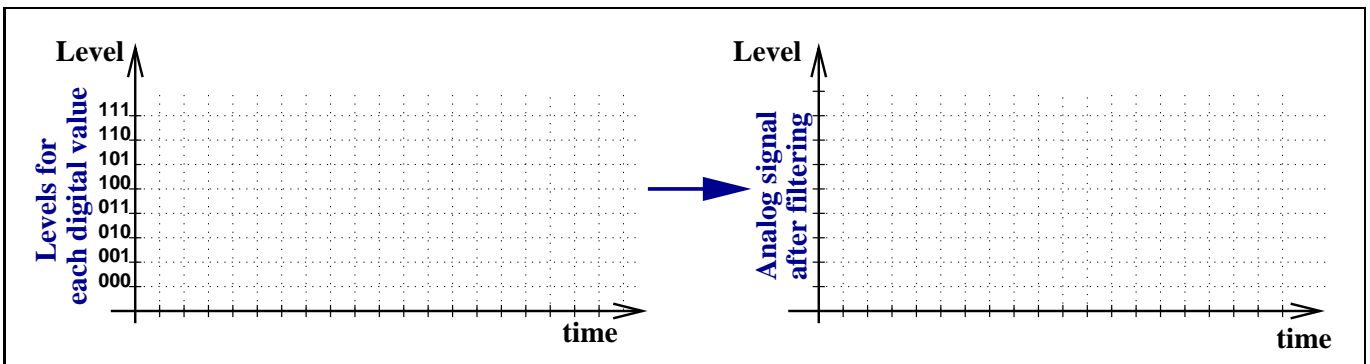


Figure 1: Filled-in answer for example question.

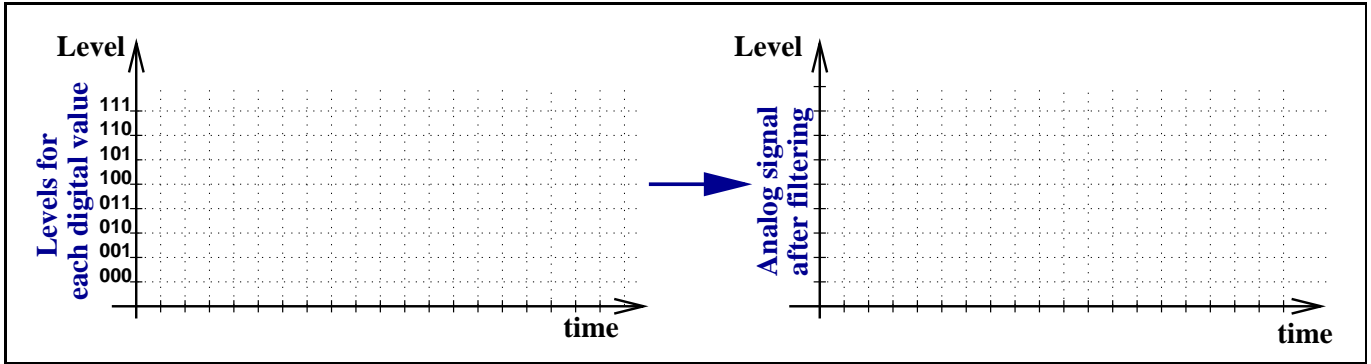
1. **Sequence:** 011 011 101 101 110 110 111 111 110 110 101 101 011 011 001 011 000 000



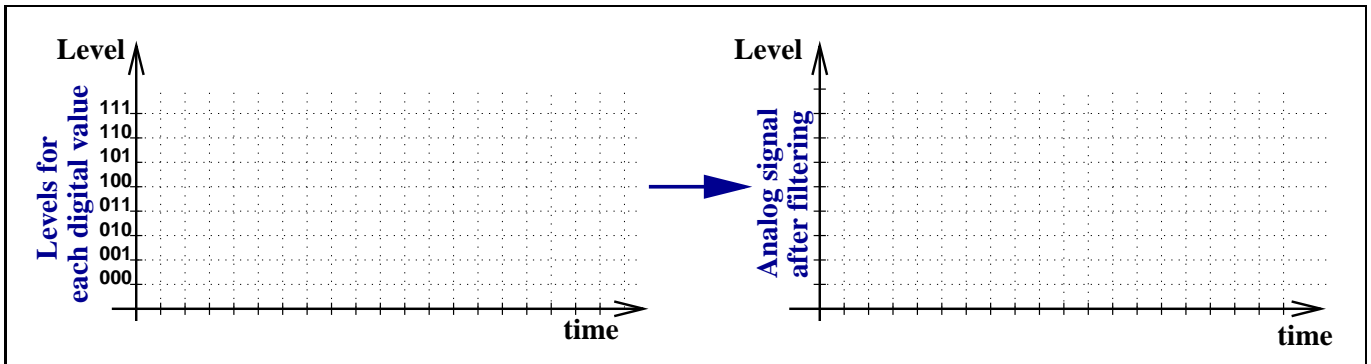
2. **Sequence:** 100 101 110 101 100 011 011 011 100 101 101 101 100 011 011 011 100 101 101 101 100



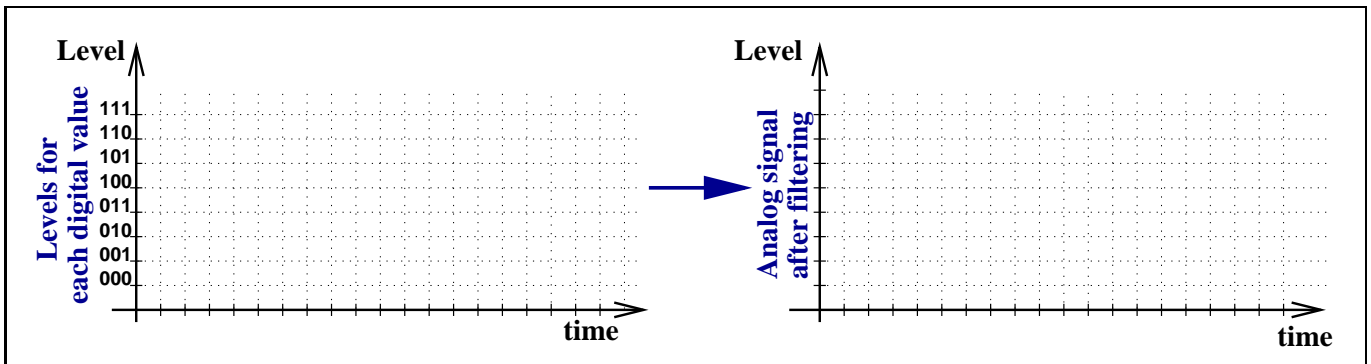
3. Sequence: 100 101 110 100 101 010 010 100 101 110 100 101 010 100 101 110 100 101 010 011



4. Sequence: 001 010 011 100 010 001 001 010 010 100 110 111 100 110 100 010 010 011 100 101 110 101



5. Sequence: 101 101 110 110 111 111 111 110 110 101 101 101 110 110 111 111 111 111 110 110 101



3 Digital Camera Operation

3.1 Color Image Formation

On the CD provided to you, under the directory **images/redgreenblue/** there are numerous images presented in full color and split into their red, green and blue components. The file names are indicative: For example, For one example, **horses.jpg** is the full-color version of a picture while **horsesred.jpg**, **horsesgreen.jpg** and **horsesblue.jpg** are respectively the red, green and blue components of this picture.

You can examine the full color pictures to try to estimate which regions will be brightest for each of the three channels, or look at only the separate-channel pictures to try to guess what color will be prominent in which regions of the full-color picture.

3.2 Grayscale Pixel-Array-to-Image Exercises

This section has two exercises similar to the box example in the Digital Camera section of the presentation.

1. On the next page is provided an empty 16×16 grid of pixels. For ease, this array is numbered. There is also a scale for different tones of gray provided, with five levels numbered from 0 to 4. For the exercise you can either use the light-to-dark (top) or dark-to-light (bottom) numbering scheme, to come up with inverse images.

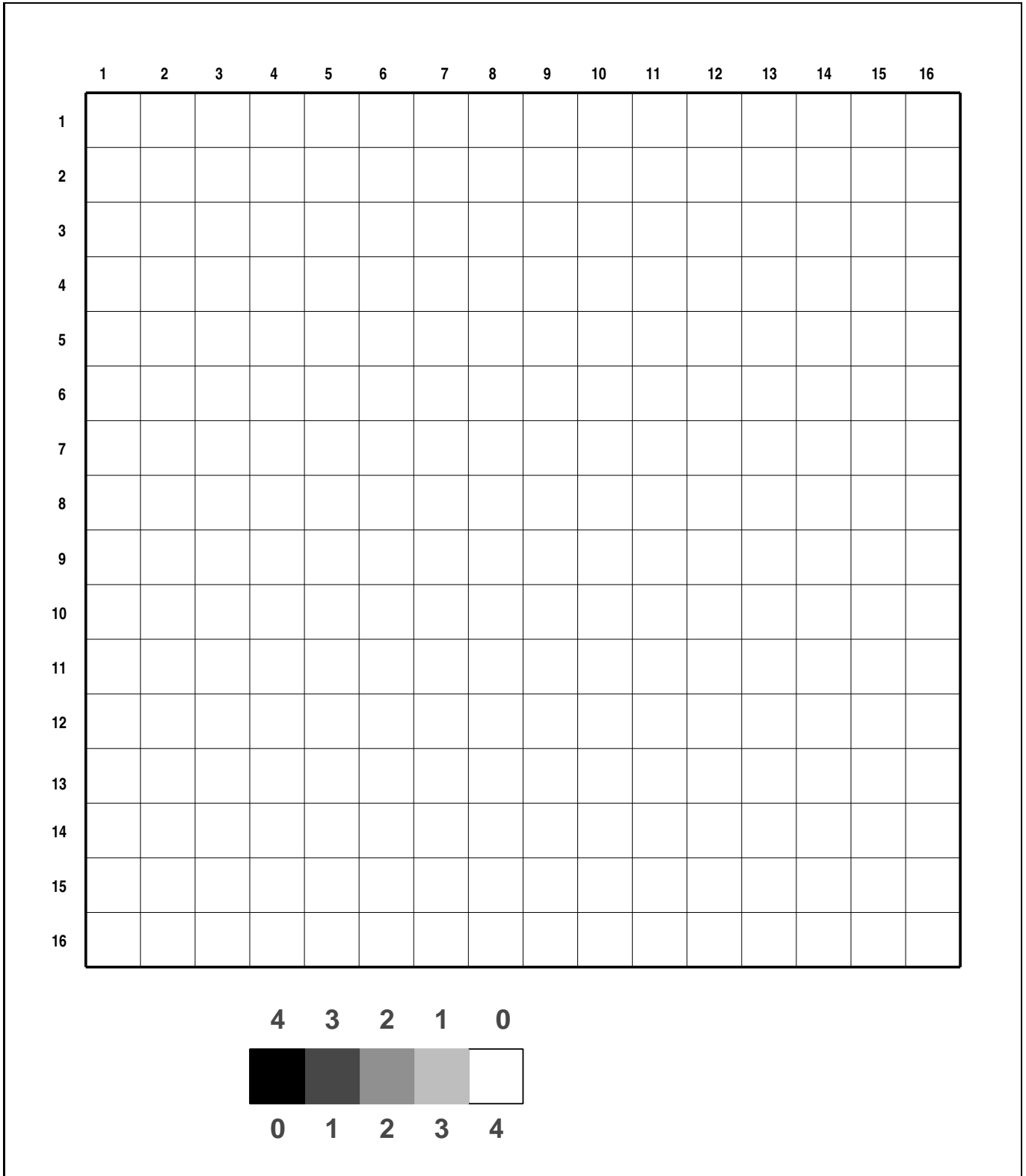
Listed below are 16 intensity values for each of the 16 rows, corresponding to the columns from left to right (from 1 to 16). Using a pencil try to shade in the “pixel”s with a tone of gray as close as possible to the number indicated for that row and column. It is possible to try this exercise with a smaller number of gray levels, to obtain a rougher image.

The result should look somewhat like the image **ballongrid.jpg**, or its negative, under the directory **images/grayscale/** on your CD.

```

Row 1.. 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Row 2.. 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Row 3.. 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Row 4.. 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Row 5.. 0 0 0 0 0 0 0 1 2 2 2 0 0 0 0 0
Row 6.. 0 0 0 0 0 1 1 2 2 2 2 2 2 0 0 0
Row 7.. 0 0 0 0 1 2 2 2 2 2 2 2 2 0 0 0
Row 8.. 0 0 0 0 1 2 2 2 2 2 2 2 2 2 0 0
Row 9.. 0 0 0 0 1 2 2 2 3 3 3 2 2 2 0 0
Row 10 0 0 0 0 2 2 3 3 3 3 3 3 3 2 0 0
Row 11 0 0 0 0 2 2 3 3 3 3 3 3 3 2 0 0
Row 12 0 0 0 0 2 2 3 3 3 3 4 4 3 3 0 0
Row 13 0 0 0 0 0 2 3 3 3 3 4 4 3 0 0 0
Row 14 0 0 0 0 0 0 0 2 3 3 4 0 0 0 0 0
Row 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Row 16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

```



2. On the next page is provided an empty 32×32 grid of pixels. For ease, this array is numbered. There is also a scale for different tones of gray provided, with eight levels numbered from 0 to 7. For the exercise you can either use the light-to-dark (top) or dark-to-light (bottom) numbering scheme, to come up with inverse images.

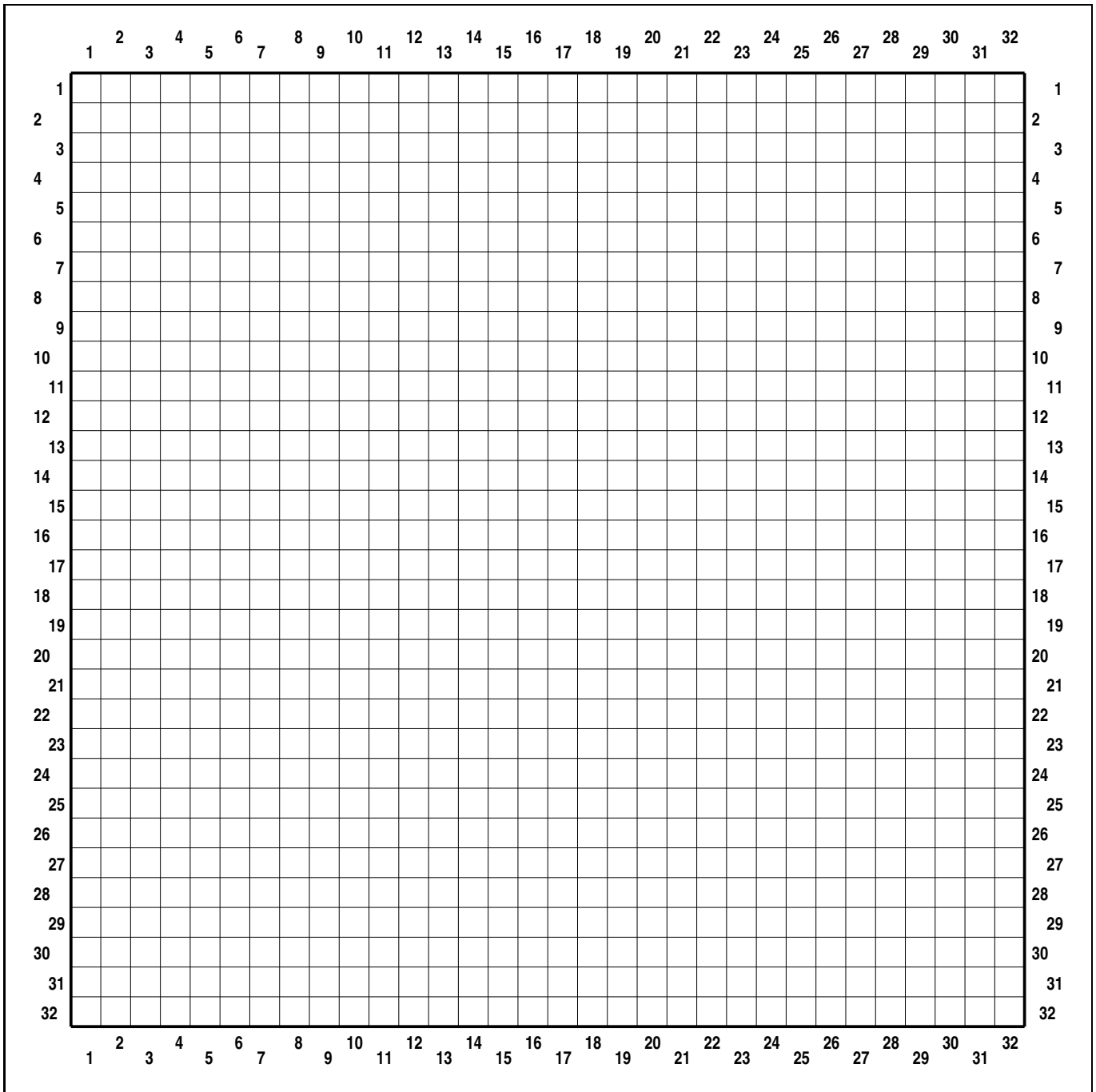
Listed below are 32 intensity values for each of the 32 rows, corresponding to the columns from left to right (from 1 to 32). Using a pencil try to shade in the “pixel”s with a tone of gray as close as possible to the number indicated for that row and column. It is possible to try this exercise with a smaller number of gray levels, to obtain a rougher image.

The result should look somewhat like the image **theghost.jpg** or **theghostinverse.jpg** under the directory **images/grayscale/** on your CD. The modified image with a small number of gray levels can be found at **theghost8levels.jpg**.

```

Row 1.. 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
Row 2.. 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 7
Row 3.. 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 7
Row 4.. 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 7 0 0 0 7 0 0 0 0 0 1 7
Row 5.. 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 7 0 0 0 7 0 0 0 0 0 1 7
Row 6.. 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 6 7 0 0 0 7 0 0 0 0 1 7
Row 7.. 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 6 6 6 1 1 1 6 7 0 0 0 0 1 7
Row 8.. 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 3 4 6 7 6 5 6 7 6 7 3 4 2 1 7
Row 9.. 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 3 4 5 6 7 6 6 4 4 4 4 4 4 2 1 7
Row 10 7 1 0 0 0 0 0 0 0 0 0 0 0 0 1 2 3 3 5 4 6 5 6 5 4 5 6 5 6 2 1 7
Row 11 7 1 0 0 0 0 0 0 0 0 0 0 0 1 4 3 5 4 4 5 4 4 4 5 3 5 6 6 4 1 7
Row 12 7 1 0 0 0 0 0 0 0 0 0 0 1 2 4 3 4 5 4 3 3 3 3 3 4 5 5 6 5 2 7
Row 13 7 1 0 0 0 0 0 0 0 0 0 1 2 4 3 3 3 5 4 3 7 3 4 5 5 6 6 7 7 2 7
Row 14 7 1 0 0 0 0 0 0 0 0 1 2 4 3 4 4 3 5 4 3 7 3 4 4 5 5 6 6 7 2 7
Row 15 7 1 0 0 0 0 0 0 0 1 2 3 3 3 3 3 4 3 4 3 3 3 4 4 5 6 5 7 5 2 7
Row 16 7 1 0 0 0 0 0 0 1 4 3 3 3 4 4 4 4 3 3 4 3 4 4 5 6 6 7 6 4 2 7
Row 17 7 1 0 0 0 0 0 4 3 3 3 3 4 4 4 4 3 3 4 4 5 5 5 4 4 5 7 7 6 2 7
Row 18 7 1 0 0 0 1 4 4 3 3 3 3 4 4 4 4 3 3 4 4 5 5 5 5 4 5 6 7 6 2 7
Row 19 7 1 0 0 0 1 4 3 4 4 3 3 4 3 3 3 4 4 4 4 5 4 4 4 5 6 7 6 2 7
Row 20 7 1 0 0 0 1 2 5 3 4 3 2 3 4 3 3 3 3 4 4 5 4 4 4 4 4 3 6 7 6 1 7
Row 21 7 1 0 0 0 1 5 4 3 3 2 2 3 4 3 3 4 4 4 4 4 4 5 4 2 4 4 6 7 6 1 7
Row 22 7 1 0 0 0 1 5 4 4 4 3 3 3 4 4 5 5 5 4 5 5 4 3 4 4 4 5 6 5 2 7
Row 23 7 1 0 0 0 0 1 5 5 4 3 3 4 5 4 1 1 1 1 1 1 2 5 3 3 4 5 6 5 2 7
Row 24 7 1 0 0 0 0 0 1 5 4 4 4 3 2 1 0 0 0 0 0 0 2 5 3 4 4 5 6 5 2 7
Row 25 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 5 3 4 4 5 5 2 7
Row 26 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 4 4 3 4 5 5 2 7
Row 27 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 5 4 3 4 5 5 1 7
Row 28 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 4 3 4 5 4 1 7
Row 29 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 5 3 3 4 3 1 7
Row 30 7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 3 3 3 3 1 7
Row 31 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 7
Row 32 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7

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4 **Notes**