CS455 - Introduction to Computer Networks
Homework 1

Solutions

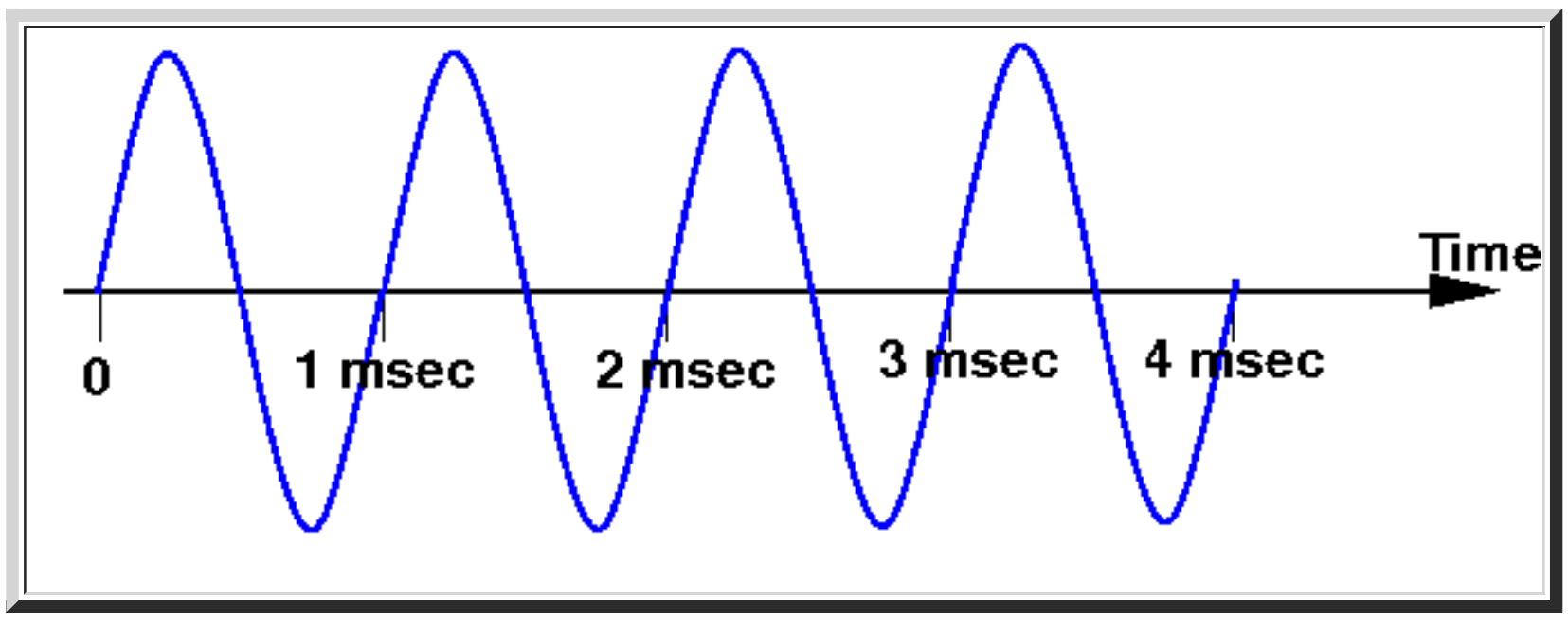
- **Question 1 (10 pts)**
  - Show the **content** that a **web browser** (such as **firefox**) will receive when you enter the following **URL** in the **browser**:

```
http://www.mathcs.emory.edu/~cheung
```

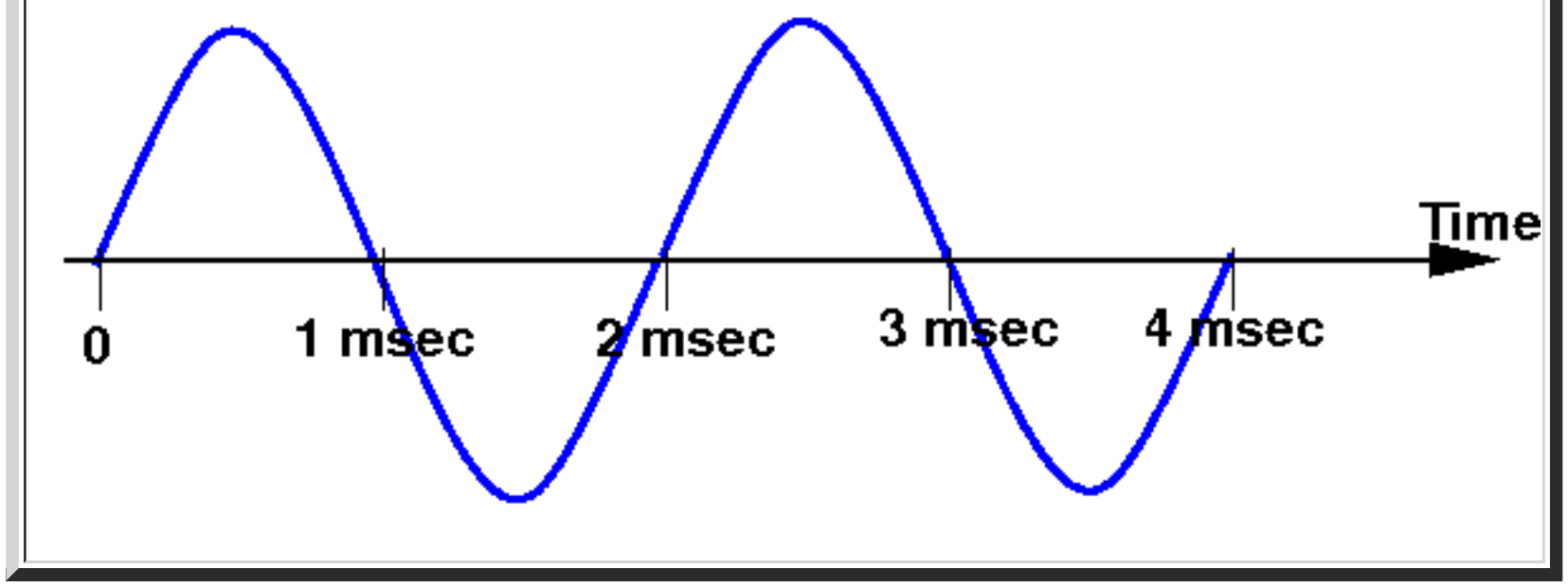
Answer:

```
Type:

   telnet www.mathcs.emory.edu  80
   GET http://www.mathcs.emory.edu/~cheung HTTP/1.0
   <ENTER>
   <ENTER>

You will received this message:

<html><head>
<title>301 Moved Permanently</title>
</head><body>
<h1>Moved Permanently</h1>
<p>The document has moved <a href="http://webhome2.mathcs.emory.edu/~cheung/">here</a>.</p>
<hr>
<address>Apache/2.0.63 (Unix) DAV/2 mod_ssl/2.0.63 OpenSSL/0.9.7d Server
at webhome2.mathcs.emory.edu Port 80</address>
</body></html>
```

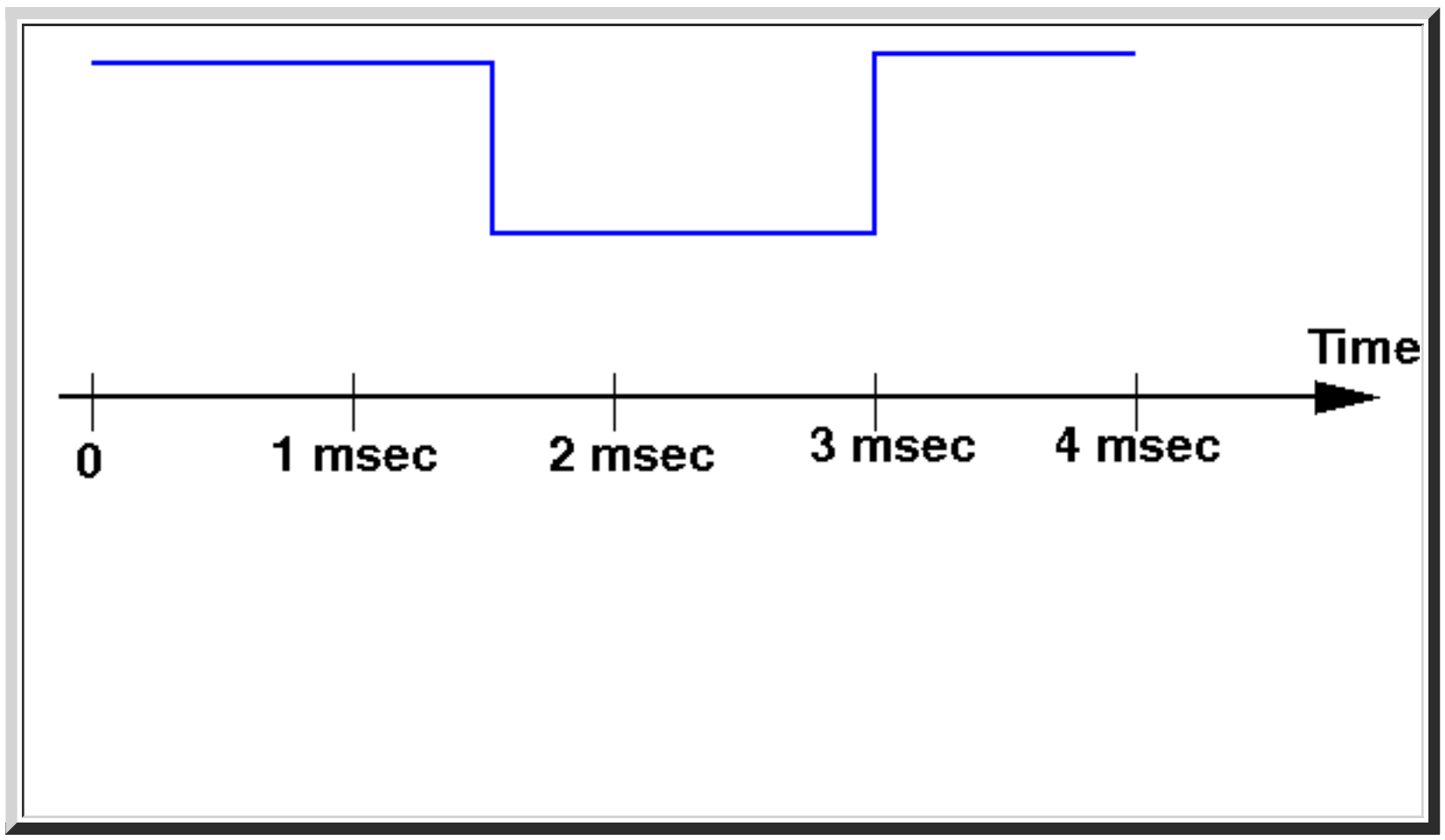
- **Question 2 (10 pts)**
  - Show in the figure below a sine wave that has the frequency of 1000 Hz (1 msec = 1 milli second = 0.001 sec):



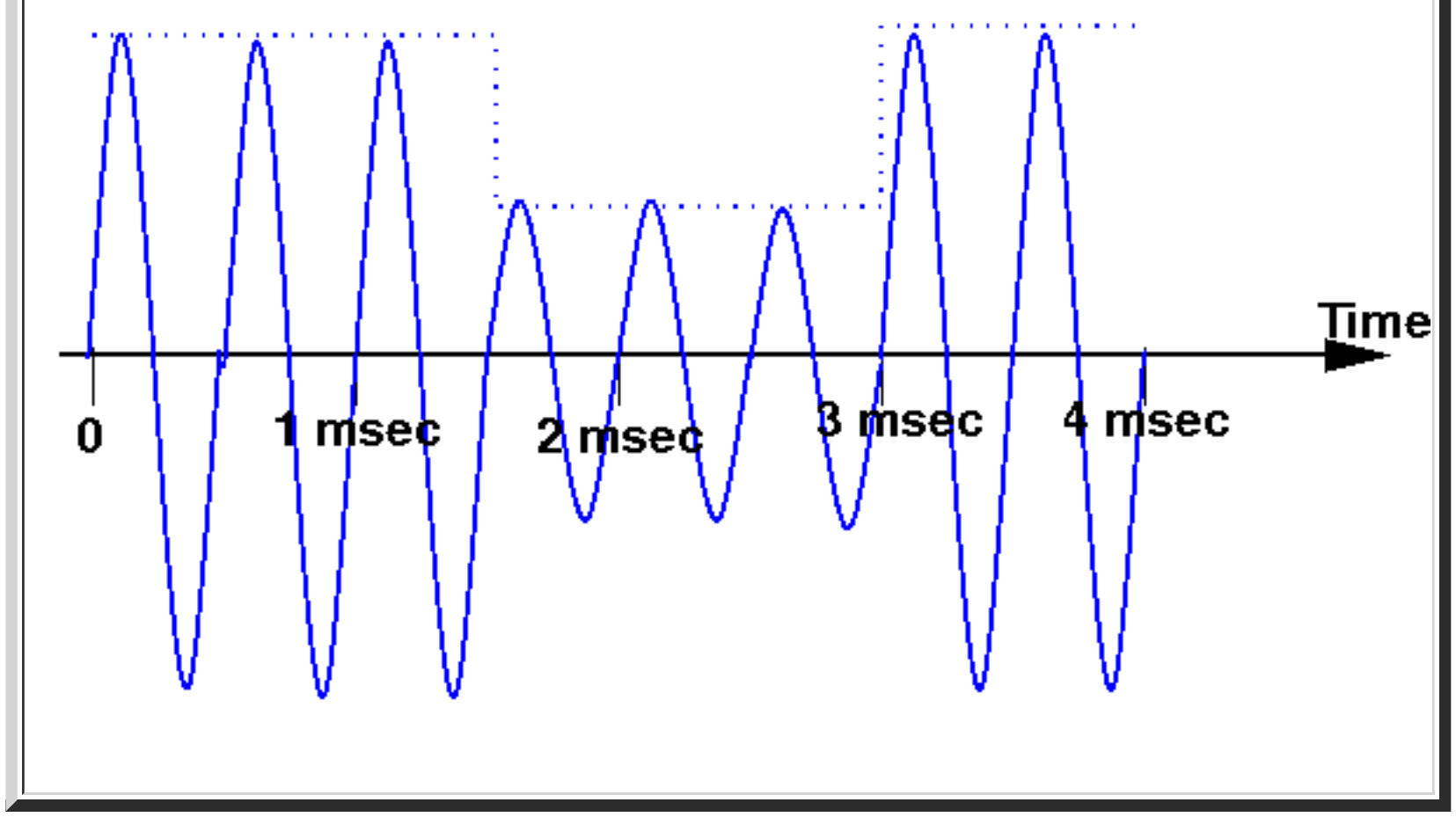
  - Show in the figure below a sine wave that has the frequency of 500 Hz:



- **Question 3 (10 pts)**
  - Consider the following **input signal**:



Show the **resulting** when the **input signal** is **modulated** onto a **2000 Hz** sine wave using **amplitude modulation**:



- **Queston 4 (20 pts)**
  - Suppose you want to improve the quality of transmission of **voice** over the telephone by transmitting all **frequencies** between **20 Hz** and **8000 Hz** over a **digital transmission channel**

    What sampling rate do you need to use to **re-construct** the **voice input** reliably ? (10 pts)

```
You need to sample at the Nyquist rate:

    2 × 8000 = 16,000 Hz
```

Each **sample** is **represented** by an **integer value** between **-64 and 63**.

What is the **data rate** of a **voice transmission** using the above scheme: (10 pts)

```
1 sample is represented by 7 bits (-64 to 63 = 128 values)

16,000 samples per sec will produce:

  16,000 × 7 = 112000 bits / sec
```

- **Question 5 (20 pts)**
  - A **sender** uses **NRZ** to transmit an **(long)** serie of **bits** to a **receiver**.

    The **receiver** **reads** the **transmission** at precisely the **middle** of its **clock** to determine the **value** of the **transmitted bit**.

    The **sender's clock** runs at **1000 Hz** and the **receiver's clock** runs at **999 Hz**.

    Suppose the **receiver** does **not re-synchronize** its **clock** to the **sender's clock**.

    If the **sender's and the receiver's clocks** are **synchronized** at the **start** of a (long) transmission, ***which* bit poistion** is the **first bit** that the **receiver** will **receive *incorrectly*** **due** to the **clock drift** ?

Answer: click here

- **Questin 6 (10 pts)**
  - Show the **digital signal** using **NRZ** when you transmit the following data:
    - 10110010 (3pts)

    Answer: click here

  - Show the **digital signal** using **NRZ** when you transmit the following data:
    - 10110010 (3pts) using **4B/5B** (4 pts)

    Answer: click here

  - Show the **digital signal** using **Manchester code** when you transmit the following data:
    - 10110010 (3pts)

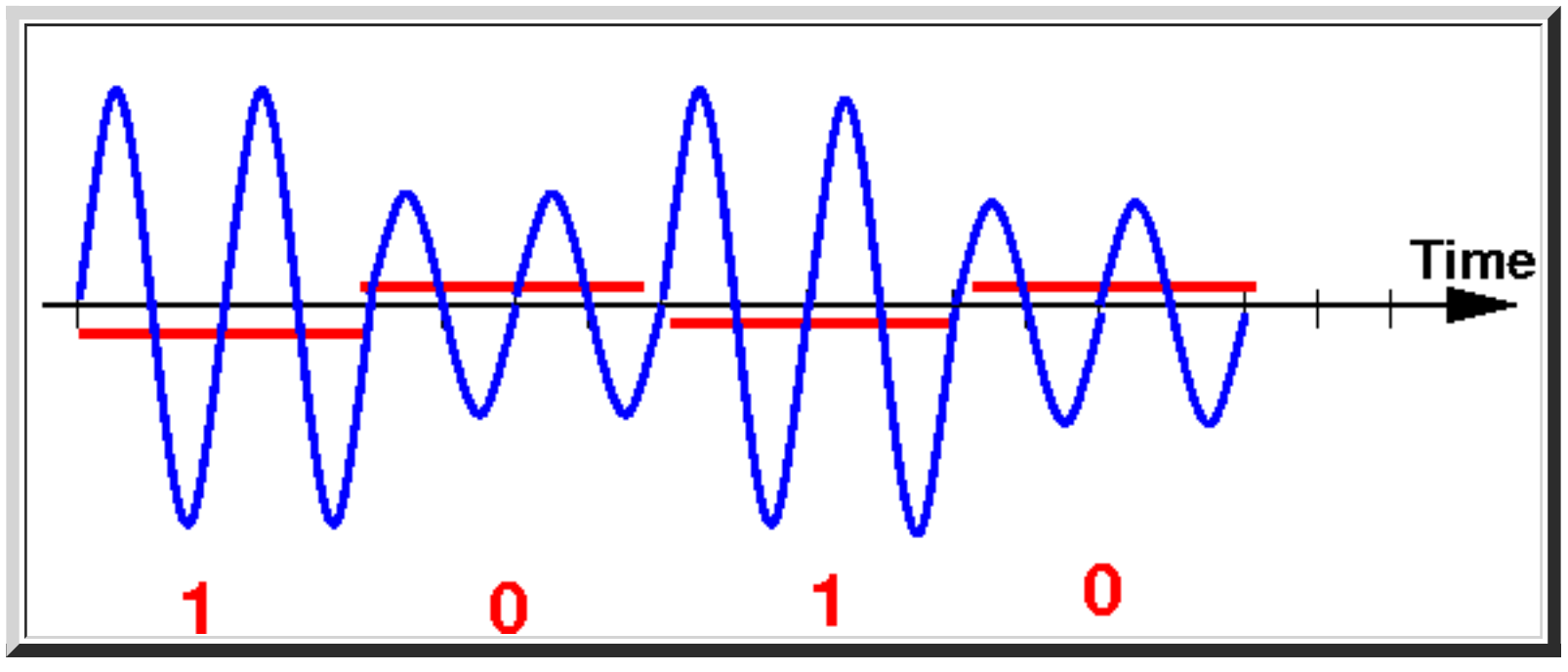
    Answer: click here

- **Question 7 (10 pts)**
  - Transmit the data **1010** using a **2-level amplitude modulation** where the **0 bits** have **half** the **amplitude** of the **1 bits**

    Use **4 units** in the **graph** below to **transmit** **each bit**

    Use **2 sine waves** for **each bit**

    Answer: (3 ots)

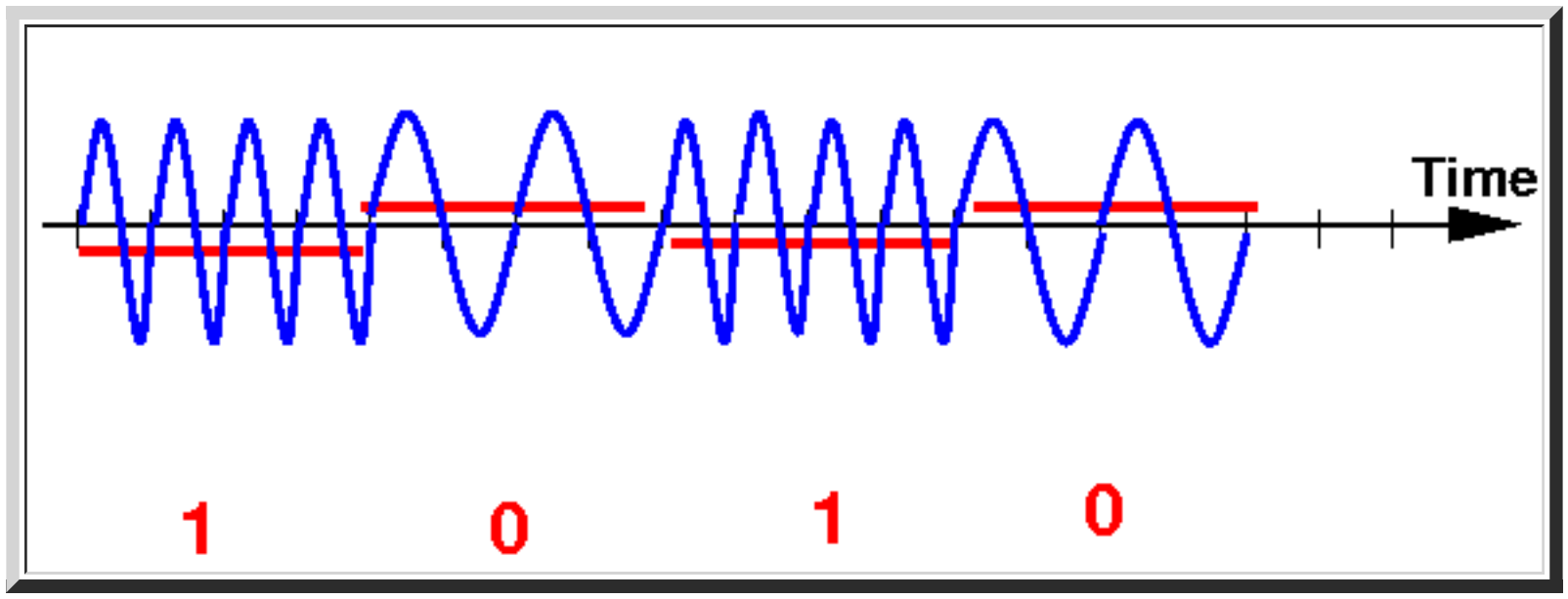


  - Transmit the data **1010** using a **2-level frequency modulation** where the **0 bits** have **half** the **frequency** of the **1 bits**

    Use **4 units** in the **graph** below to **transmit** **each bit**

Use **2 sine waves** to transmit a **0 bit** and **4 sine waves** to transmit a **1 bit**

Answer: (3 pts)

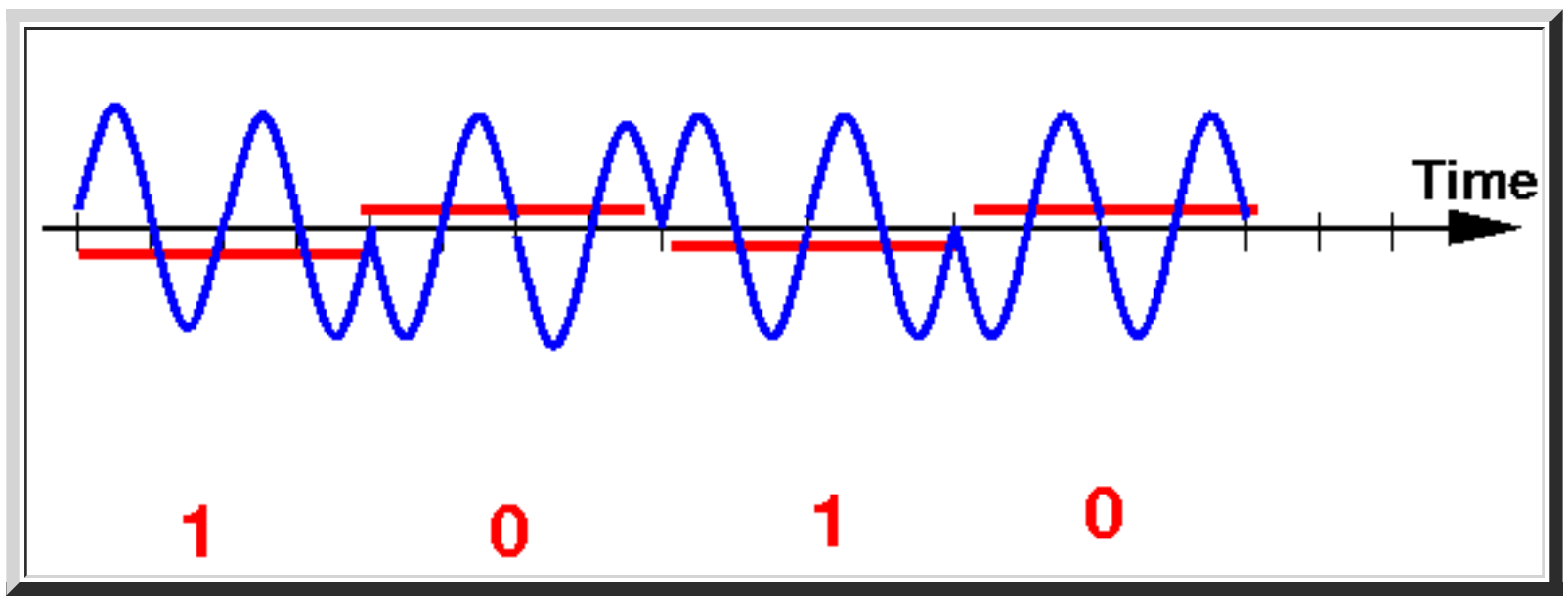


- Transmit the data **1010** using a **2-level phase modulation** where the **0 bits** have **0 phase shift** and the **1 bits** have **180 degrees phase shift**

  Use **4 units** in the **graph** below to **transmit each bit**

  Use **2 sine waves** to transmit a **each bit**

  Answer: (4 pts)



- **Question 8 (10 pts)**
  - Suppose that the **bandwdith** of optical fiber is **1 GHz**

    If the the **signal to noise** ratio is **100**, what is the **maximum data transmission rate** on this optical fiber: (5 pts)

```
MAx data rate = Bandwidth × 2log(1 + S/N)
              = 1,000,000,000 × 2log(1 + 100)
              = 1,000,000,000 × 6.658
              = 6,658,000,000 bits / sec
              = 6.658 Gbps
```

    If the the **signal to noise** ratio is **1000**, what is the **maximum data transmission rate** on this optical fiber: (5 pts)

```
Max data rate = Bandwidth × 2log(1 + S/N)
```

$$= 1{,}000{,}000{,}000 \times {}^{2}\log(1 + 1000)$$
$$= 1{,}000{,}000{,}000 \times 9.967$$
$$= 9{,}967{,}000{,}000 \text{ bits / sec}$$
$$= 9.967 \text{ Gbps}$$