



Section- A

There are **THREE** questions in this section. Answer all **THREE** ($3 \times 6 = 18$).

1. Misir Ali, a famous scientist working at NASA, has received a signal from outer space recently. With his vast knowledge on Fourier Transform, he has transformed the signal in frequency domain. NASA has asked Misir Ali to find the Bandwidth of that signal. Misir Ali knows that first zero-crossing point is vital to determine the bandwidth. He has written the Fourier Transformed signal in frequency(ω) domain as:

$$F(\omega) = \frac{4\pi\theta \sin\left(\frac{\omega\tau}{\pi}\right)}{\tau\omega^2 \left(\omega^2 - \frac{\pi^4}{\tau^2}\right) \left(\omega^2 - \frac{9\pi^4}{\tau^2}\right)}$$

Here τ , θ and π are constants. Now help Misir Ali by finding the bandwidth of the above-mentioned signal. [6]

2. (a) Entropy describes how much information there is in a signal. Shannon introduced the idea of information entropy in his paper "A Mathematical Theory of Communication." Shannon defined entropy as a measure of the average information content associated with a random outcome. Now using the idea of entropy, justify the following statement with an example. The more uncertain the data is, the more information it carries. [3]

- (b) Three machines are sending some data to a remote receiver. They use a stream of symbols to represent their data. The symbol set is $S = \{0, 1, 2, 3, 4\}$. The streams that are sent by the machines in last one hour are given below:

Data sent by Machine A: 20104342310324123014

Data sent by Machine B: 01000423

Data sent by Machine C: 440443444241

You need to find the machine that contains maximum information by using Information entropy. [3]

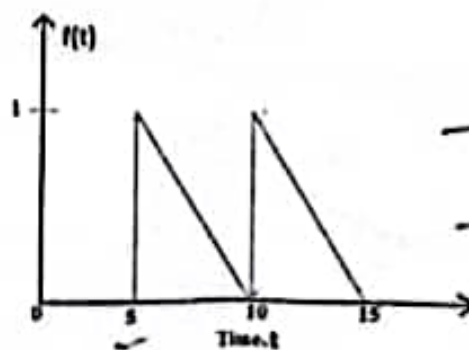


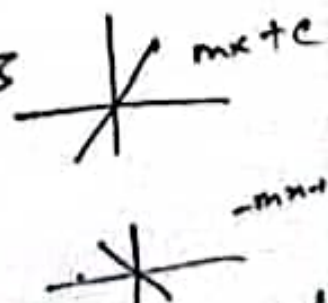
Figure 1: Signal in time domain

$$\frac{2\pi^2}{T} + \frac{\pi^2}{T}$$

$$\frac{3\pi^2}{T} = \frac{2\pi^2}{T}$$

$$- 5 + 10$$

$$- 5 + 13$$



3. Dr. Jeremy Wade is a famous biologist. Recently, he is researching on how fishes can communicate with each other. While observing some big catfish, he has found that they use a special signal for communication. Dr. Wade has drawn the figure 1 showing the signal in time domain. [6]
Now find the equation of that signal in frequency-domain.

Section- B

There are FIVE questions in this section. Answer any FOUR ($4 \times 3 = 12$).

4. Suppose, the following Bit stream has been transmitted to the receiver's data link layer. Now show the frames and their data using Framing with Bit Stuffing. Consider the flag pattern 0111110 and the general rules of Bit Stuffing in data frames. [3]
011111001101111001110111100111100111101011110110111101010100010001111011111011101111101011001111000111110
5. (a) High-frequency carrier signals are essential for data communication. Suppose, you are using a carrier signal represented as $A_c \sin(\omega_c t + \theta)$. To use this signal for transmitting some message signal, you will need something called "modulation". Explain different ways in which the message signal can be modulated by the carrier signal. [1.5]
- (b) Trump and Putin are two friends arguing on framing techniques. Trump wants to use Byte Count technique. But Putin likes Byte Stuffing technique. Trump thinks Byte Count technique is simple and can easily be understood. Putin thinks Byte Stuffing technique is efficient and less vulnerable to noise. Why does Putin think Byte Stuffing is less vulnerable to noise than Byte Count technique? Support your position with an example. [1.5]
6. Determine the truth value of the following statement. Support your position with an example. Show illustration with proper labels. [3]
"Modulating signal(message signal) bandwidth is B Hz. After amplitude modulation, modulated signal bandwidth will be $2B$ Hz."
7. (a) Suppose, you are a researcher at Palo Alto Research Center(PARC). Your team is working on a project. To help your colleagues, you need to design a network architecture. You know the advantages of layered architecture reference model. So, you've decided to design the network using a stack of layers. Why do you prefer a layered architecture model over a single layer architecture model? Give two reasons. [2]
- (b) Determine the truth value of the following statement. Support your position with proper reasonings. [1]
"A protocol is defined as a set of rules while interfacing one layer in a reference model with another layer in the same reference model."
8. Suppose, you are watching a short clip on Youtube. The video was an HD video with each frame size (1280 x 720) pixels. Video length was 5 sec. After downloading the video, the total size of the video becomes 54,000 kB. Each pixel size is 3 Bytes. What is the frame rate of the video? [3]
Hints: Bit rate = Frame rate * Frame Size. The frame rate is the number of frames per second.