ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 8, February 2013

Signals Concept with the Help of Theory and Sketch on Paper or On Graph Paper

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Abstract*— Aim of the present paper is to bring out the concept of signals. Secondly our main motto is to explain the way by which the signals are plotted on the graph papers and how the signals are seen in the oscilloscope kept in laboratories. This paper is an outcome of teaching and professional experience. In this paper, main thrust is to elaborate the signals concept that till date remained untouched, that is the signals are plotted but not broadly explained how these are exactly take the shape on paper or in oscilloscope. This paper not only discusses the new way to explain the signals but also tells step by step drawing of signals. The plotting of signals plays a vital role in the study of signals & serves as basic building block to understand the signals in deep. This paper elaborates a new approach to explain the signals hence it is named as above. In a nut-shell, this paper tells how a imagined cycle is stretched on the paper and in the oscilloscope.

***Index Terms*— SP's – Satyapal's, Angle – The Angles At Which Shape Of The Elementary Signal Changes, Clockwise – The Direction Of Watch, Anticlockwise – The Opposite Direction Of Watch.**

I. INTRODUCTION

Signal is related to each one of us. Signals and Systems is a separate subject in engineering courses where normally, the first chapter is related to the definition of signal, its types and characterization etc. These terms are dealt with related signals construction problems. Apart from this, it deals with the different elementary signals such as unit step, ramp etc. functions. While I was taking the elementary signals problems, a number of students faced a lot of problems in understanding the problems. After a long meditation, I found one solution and I started writing on this. This solution was nothing but unknowingly became my research subject and this solution solved the problems of the students. Some of the thoughts have been published in the international conference as well as in international journals too. However, the work is still 'ON' and hope in days to come will give more research papers on the same subject. The present paper is nothing but the study of signals concept and plots of it. The present paper will try to reveal signal concept as well as plotting methodologies on paper and in oscilloscope. It will also try to elaborate the analysis of signals in the form of examples so that one can understand the theory developed.

II. LITERATURE SURVEY TO THE RELATED WORK

Signal is the study of different shapes of waves that are required to be analyzed in the field of electronics and communication. Of course, the study of signals is a tough job if not studied and understood properly. The present effort will be focused on the concepts that have been drawn while teaching in Engineering College and these concepts are very much essential to draw the shapes of different types of signals. This work will be mainly based on how to construct the elementary signals using the theory being developed and secondary job will be the analysis in the form of examples. The present effort will focus on the concepts that have been drawn purely on the basis of professional and teaching experiences and these concepts are very much essential to draw or plot the shapes of different types of signals. The signals are of prime importance whether the study is concerned with computer science or engineering or any other field of engineering. One has studied very well that the bulb using AC current in home appliances in India works on 50 hertz. But how many of us have observed the cycles, except imagining that the bulb when lights oscillates but how, hardly one can answer. First attempt of this topic will be to make known what is the meaning of oscillations and secondary attempt will be to tell sketching procedure that is used practically or understood. Before understanding this, one should understand the topic as discussed in the next headings. The next headings not only clears the idea of oscillations but exactly clarifies how a periodic signal is considered in the communications engineering or allied engineering fields. This paper will try to provide the answers of this type of questions. As no matter is available in the books or on internet of my approach, I consider that this topic is untouched that now is going to be discussed. Hence, on the basis of this statement I would like to declare that literature survey for this topic is not available, however if one could provide me the matter from older books, I will thankful. Presently, it is considered that this topic is having nil literature materials and hence there is no problem I call it as SP's concept of signals for plotting on paper etc. Apart from this, let us have the idea of signals in following manner – Let one considers a telecommunication system then signals could be in the following form –

- Speech
- Television
- Facsimile, and
- Personnel computers

Speech signal: As has been mentioned above, the speech signal is an AC signal. Speech signal is the primary method for human communication. Basically, the speech communication process involves the transfer of information from a speaker to a listener, which takes place in three successive stages as under –

a. Production: An intended message in the speaker's mind is represented by a speech signal that consists of sounds (i.e.

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pressure waves) generated inside the speaker's mouth and whose arrangement is governed by the rules of language.

b. Propagation: The sound waves propagate through the air, reaching the listener's ears.

c. Perception: The incoming sounds are deciphered by the listener into a received message and thus completing the chain of events that results in the transfer of information from the speaker to the listener.

In fact, the speech-production process may be viewed as a form of filtering, in which a sound source excites a vocal tract filter. The vocal tract consists of a tube of non-uniform cross-sectional are, beginning at the glottis (i.e., the opening between the vocal cords) and ending at the lips. Now, as the sound propagates along the vocal tract, the spectrum (i.e., the frequency content) is shaped by the frequency selectivity of the vocal tract. This effect is quite similar to the resonance phenomenon observed in organ pipes. At this stage, it may be noted that the hearing mechanism is highly sensitive to frequency. In addition to this, the type of communication system being considered as an important bearing on the bond of frequencies considered to be essential for the communication process. As an example, a frequency band from 300 to 3100 Hz is considered adequate for telephone communication on a commercial basis. Similarly, other source of information (signals) is televisions that refers to the transmission of pictures in motion by means of electrical signals. To accomplish this transmission, each complete picture has to be sequentially scanned. The scanning process is carried out in a TV camera. In a black and white TV, the camera contains optics designed to focus an image on a photocathode consisting of a large number of photosensitive elements. Third type is facsimile or fax, the purpose of this type of information (signal) is to transmit still pictures over a communication channel (most notably, a telephone channel). Such a machine provides a highly popular facility for the transmission of hand written or printed text from one point to another. Further, transmitting text by facsimile is treated simply like transmitting a picture. Fourth one signal is personal computer signal; personal computers are becoming increasingly an important part of our daily lives. We use them for electronic mail, exchange of software, and sharing of resources. It is estimated that over 30 percent of the personal computers in use today are already networked and the number is increasing rapidly. The text transmitted by a personal computer is usually encoded using the American Standard Code for Information Interchange (most popularly known as ASCII Codes), which is the first code developed specifically for computer communications. This is nothing but a tour of signals that we use in our daily life and all the signals have their shapes which are required to be known by an engineering students and technocrats. Hence, the concept of signals and plotting of signals is considered to be very important.

III. CONCEPT OF SIGNALS

The term Signal is very easy to listen and good to feel as most of the human being considers this as an indication, of course it is indication but when we talk about signal in terms of engineering or scientific language then it carries a lot more meaning. As we see and use signal in a easy way in daily life, but most of the technocrats and students are either unaware or confusing of what exactly is the signal. The signal is having other names too such as beacon, semaphore etc. or any other type of indication that provides some sense to convey some or a bit or bits of information or to make some sense from that indication. Here, it is quiet mandatory to define what actually signal is – the signal can be defined as – Signal is a function which is dependent on one or more independent variables or signal is a function of one or more independent variable(s) that provides information about the behaviour or nature of some phenomena. Examples of signal – current signal, voltage signal, TV signal, radio signal, ECG signal, picture signal etc. In most of the practical cases, signals are dependent only on one independent variable that is time (t). Apart from this, signals are dependent on more than one independent variable too – for example TV signal is dependent on two variable i.e. x and y and ECG signal is even more than two independent variables[1,2,3]. How a signal can be seen? Normally we can see signal in oscilloscope or can be depicted on graph/simple paper etc. But an individual is not able to imagine how the signal is exactly stretched in oscilloscope or how is the signal drawn on paper or how the signal is formed in the oscilloscope. Normally, we observe different kind of signals in oscilloscope but rarely there is anyone who has explored that how this signal is being seen to the human being. The main idea or logic here is to elaborate the basic term signal so that the technocrats and students may be benefited.

Normally, the technocrats observe the following types of signals –

- Sinusoidal signals (sin or cosine)
- Rectangular signals etc.
- Or any other shaped signals..

IV. CONSTRUCTION OF SIGNALS

To understand and to know the procedure of sketching of a sinusoidal signal, let a player is running along a circular path as shown in figure 1. The runner starts running constantly from let point 'a', the origin, at time t=0 sec in clockwise direction. Let the runner takes 30 seconds to complete the half of the path i.e. reaches to point 'b'. After completing half of the path, the runner follows the same remaining path with same constant speed and reaches to the origin i.e. at point 'a' and he takes another 30 seconds from point 'b' to point 'a'. It means he has completed one round or scientifically he has completed one cycle. Now the crucial point comes to understand the signal. After completing half of the path, the runner should take another 30 seconds but the runner has reached to the origin where the graph shown in figure 1 shows time scale is crashing i.e. at this point 'a', we get t = 0 sec whereas actually it should have been shown time t = 60 seconds as the runner has taken total time of 60 seconds to cover the circular path distance. Keeping the importance of this fact, the designers/scientists/technocrats thought to plot the signal in such a way so that the meaning of signal could be

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ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
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understood and could be plotted on a graph paper or could be plotted and seen in the oscilloscope. Hence, to indicate that the runner has taken *total 60*" *seconds* to cover the circular path, first half of the path is taken as the runner has followed and second half is rotated towards right as shown in figure 2. Now this figure 2 gives the clear picture of the circular path that the runner has consumed 30 seconds to cover half of the path and another 30 seconds has been consumed to cover the rest of the path that is, now the runner has completed full circle and clearly taken 60 seconds and hence it necessarily provides the shape of sinusoidal signal. Thus actually, any signal if has fixed path always then it roams in that fixed path only and we say for circular path only one circle which does not provide the actual meaning of the signal, hence the second half is rotated in right direction. Same logic is followed to plot the signal in oscilloscope that is first half is shown as it is and in second half, the oscilloscope is constructed in such a way that the second half cycle is extended in time scale toward always positive side as time always increases and takes positive value and this gives a clear picture of a sinusoidal waveform. Thus this type of signal shows that the shape changes with respect to time i.e. signal is dependent on time and change in shape is with respect to time. Same method is applied while depicting the signal on a piece of paper or on a graph paper.

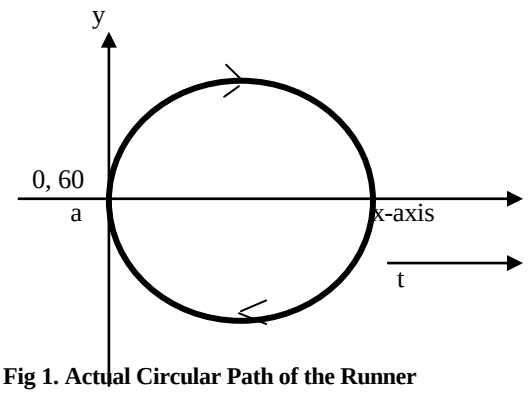

Fig 1. Actual Circular Path of the Runner

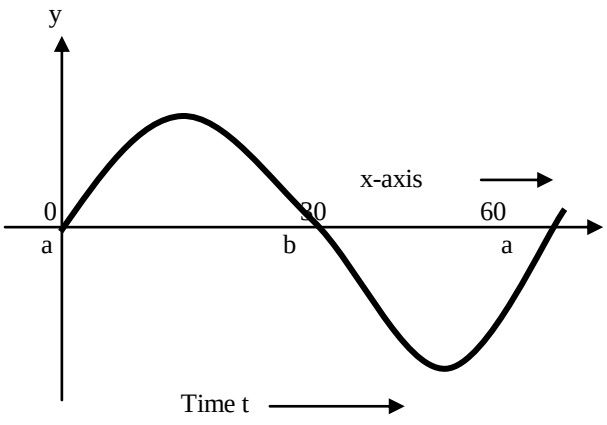

Fig 2. Time Sensing Circular Path of the Runner

Similarly, if the runner runs in a rectangular or in any other shape, then by following the same logic as explained above the shapes of a signal (periodic) can be plotted. The rectangular example is shown in figures 3 and figure 4.

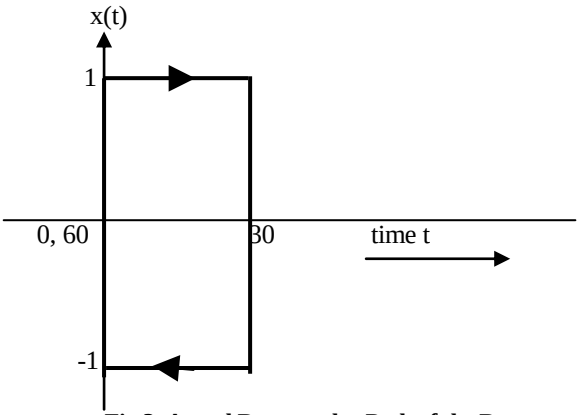

Fig 3. Actual Rectangular Path of the Runner

The signals which follow the same path in same time provide the similarity in their cycles and termed as **periodic signals** whereas if the signals that do not show this type of similarity that is if the signal has dissimilarity in their cycles are called **a periodic signals**.

Hence, periodic signal is defined as –

A signal that repeats its shape after a fixed interval of time is called **periodic signal** as the runner took the two semi-circular shapes. Figures 2 and 4 are the examples of periodic signals. The periodic signals are represented mathematically as –

$x(t + T) = x(t)$, where T is fundamental period of signal x(t) and repeats the cycle of a signal after time T. For example $x(t) = \sin\omega t$ is a periodic signal with fundamental period $T = 2\pi/\omega$. Let $\omega = 22/7$ then T = 2 sec that is this sinusoidal signal will repeat its cycle after 2 sec means after 2 sec and upto 4 sec we will get the same shape as we got previously.

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Volume 2, Issue 8, February 2013

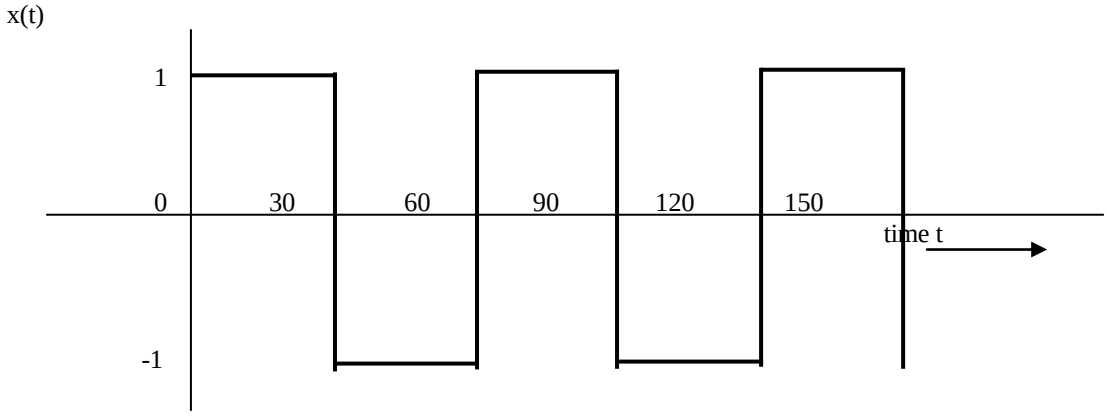

Fig 4. Time Sensing Rectangular Path of the Runner.

Whereas, **Aperiodic or Non-periodic signal** is another type of signal that has different type of characteristics that is it is represented as $x(t + T) \neq x(t)$, means a non-periodic signal does not repeat its cycle and may take any arbitrary path. This type of signal may have one period and that to be equal to infinity or different fundamental periods for each cycle. A non-periodic signal is defined as – "A signal that does not have definite pattern i.e. does not repeat its waveform after a fixed period is called aperiodic (or non-periodic) signal. Thus any pattern of signal which is not periodic is called a non-periodic signal". It is as good as the runner runs in any arbitrary path and does not follow any specific path. Means the runner does not run in any fix shape but runs in an unspecified irregular path. Let the runner takes first round trip in a rectangular shape and takes 60 seconds to complete first round and in another round he runs in circular shape and takes 160 sec and in another (third) round he runs in some other shape and takes some other time to complete the trip and so on, then the shape will not be fixed but it will be in changing shape in every round trip. This process is shown in figures 5 and 6. Same time some other arbitrary paths are shown in subsequent figures.

Thus signal shown on a piece of paper is *in time extended form* and is not the actual. This indicates that signal shape remains at one position for a path but to make a sense, signal is extended on the variation of time which gives the actual shape. Hence, a signal is a function representing a physical quantity or variable and typically it contains information about the behavior or nature of the phenomenon. For instance, in an RC circuit the signal may represent the voltage across the capacitor or the current flowing in the resistor. Mathematically, a signal is represented as a function of an independent variable t, usually t represents time which always having the nature of variation. Thus, hence, in this way a signal x is denoted by x(t) on paper to tell that x is a signal which is dependent on independent variable time (t). Thus, the concept of plotting the signal on paper, graph paper or to show in oscilloscope is to mark the amplitude of the signal at different times which gives the shape of signal. Similarly, if the athlete takes an unspecified route then that route also can be shown in a similar fashion.

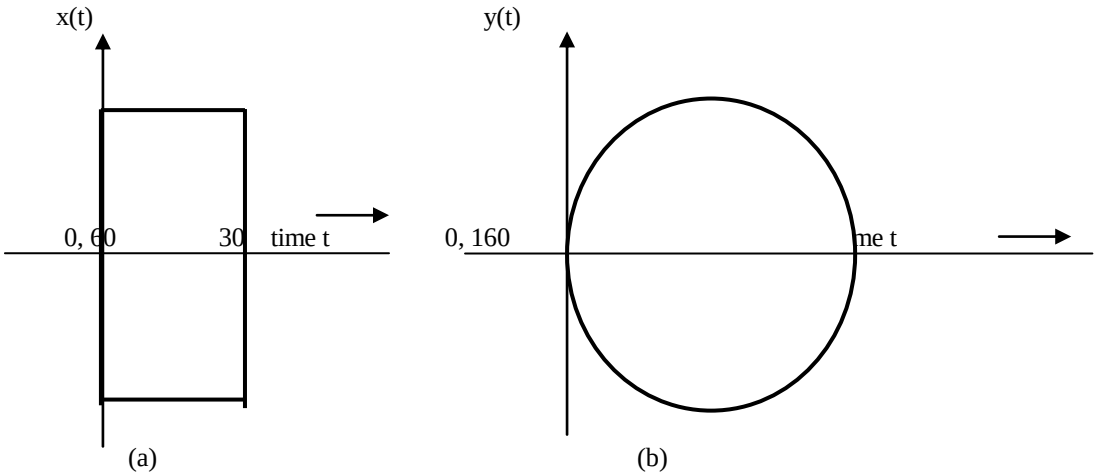

Fig 5. (A) Actual Rectangular and (B) Circular Paths of the Runner

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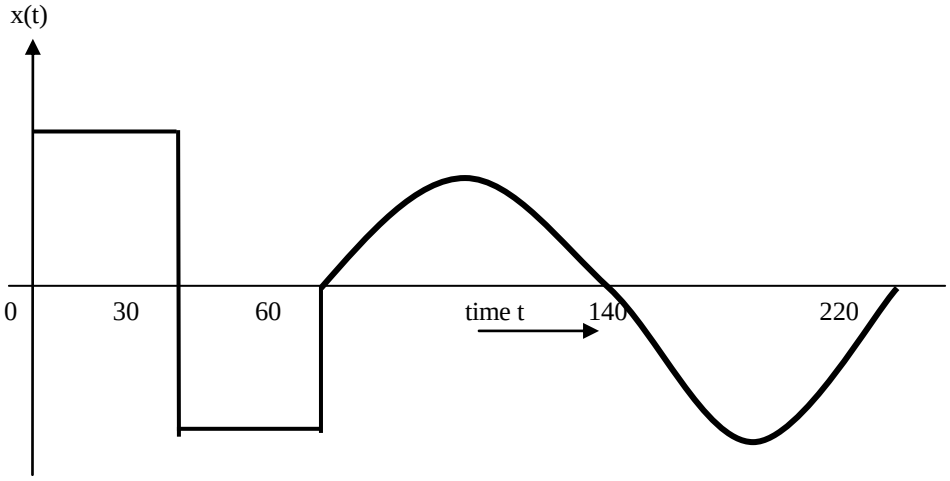

Fig 6. Time Sensing Path Followed By The Runner

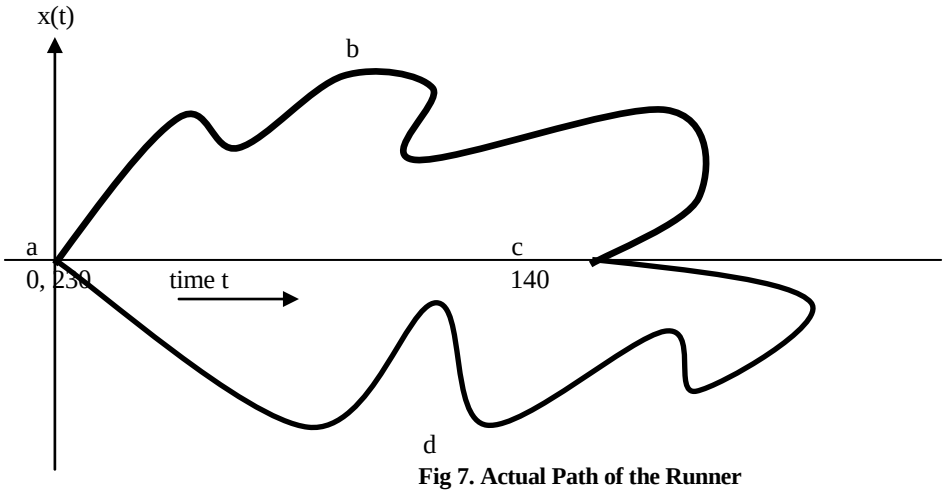

Fig 7. Actual Path of the Runner

Let in this example shown in figure 7, the runner takes the path as shown above. Let us hope that the runner takes 140 seconds to cover path abc and the runner takes 90 seconds to cover rest half of the path cda. It means he/she takes total 230 seconds to cover the total path. If we see the figure 7, then it clashes at time = 0 point.

To reduce this ambiguity or to nullify the doubt, the lower part is rotated toward right as shown below and this figure 8 clearly shows the time taken by the runner. The path when drawn in time sensed way, we get the final graph as shown below -

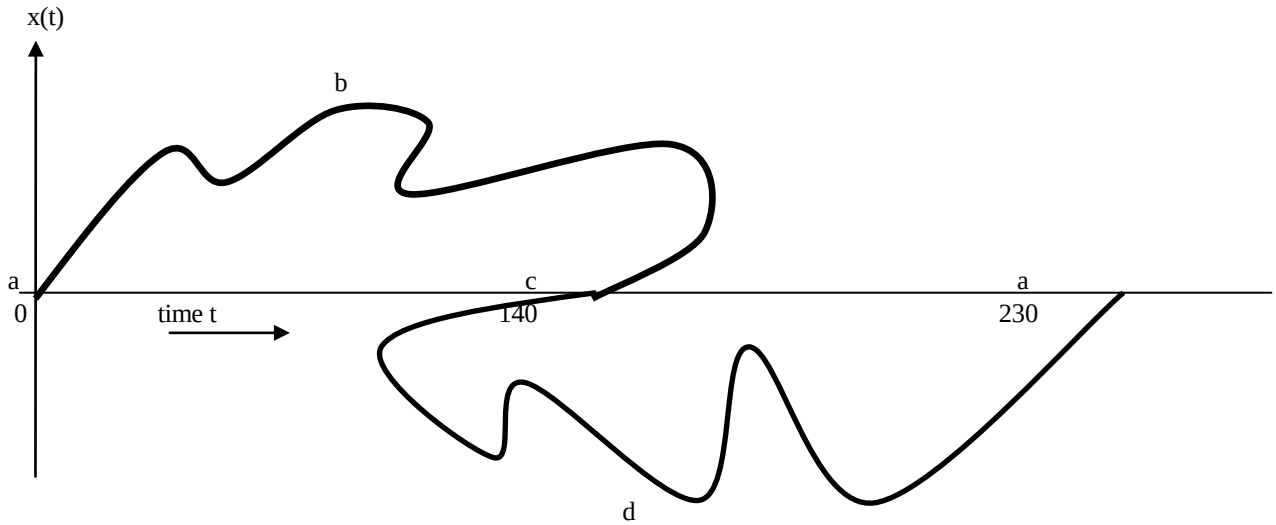

Fig 8. Time Sensing Path Followed By the Runner

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ISO 9001:2008 Certified
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Let us have a path shown in figure 9. The runner takes the path as shown as below. Let us hope that the runner takes 60 seconds to cover path abc and the runner takes 120 seconds to cover rest half of the path cda. It means he/she takes total 180 seconds to cover the total path. If we see the figure 9, then it clashes at time = 0 point.

To reduce this ambiguity or to nullify the doubt, the lower part is rotated toward right as shown below and this figure 10 clearly shows the time taken by the runner. The path when drawn in time sensed way, we get the final graph as shown below -

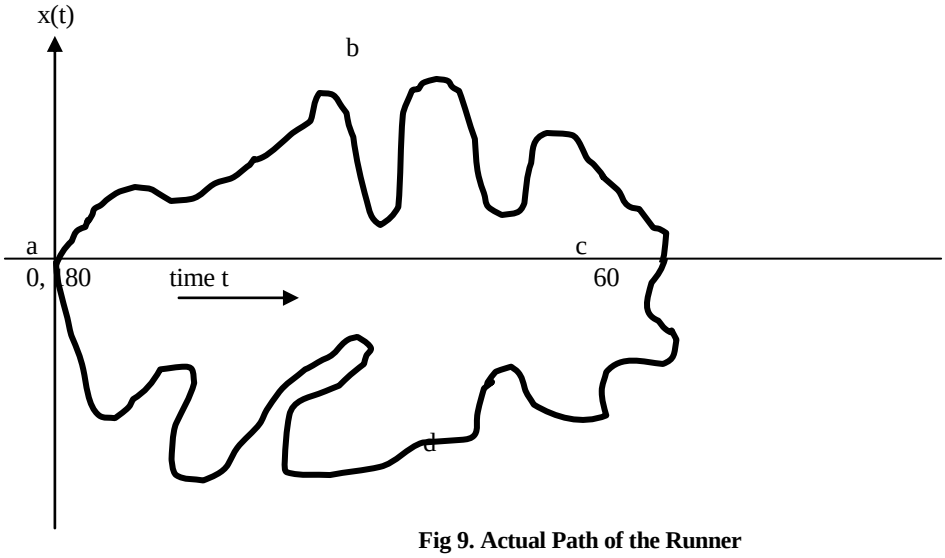

Fig 9. Actual Path of the Runner

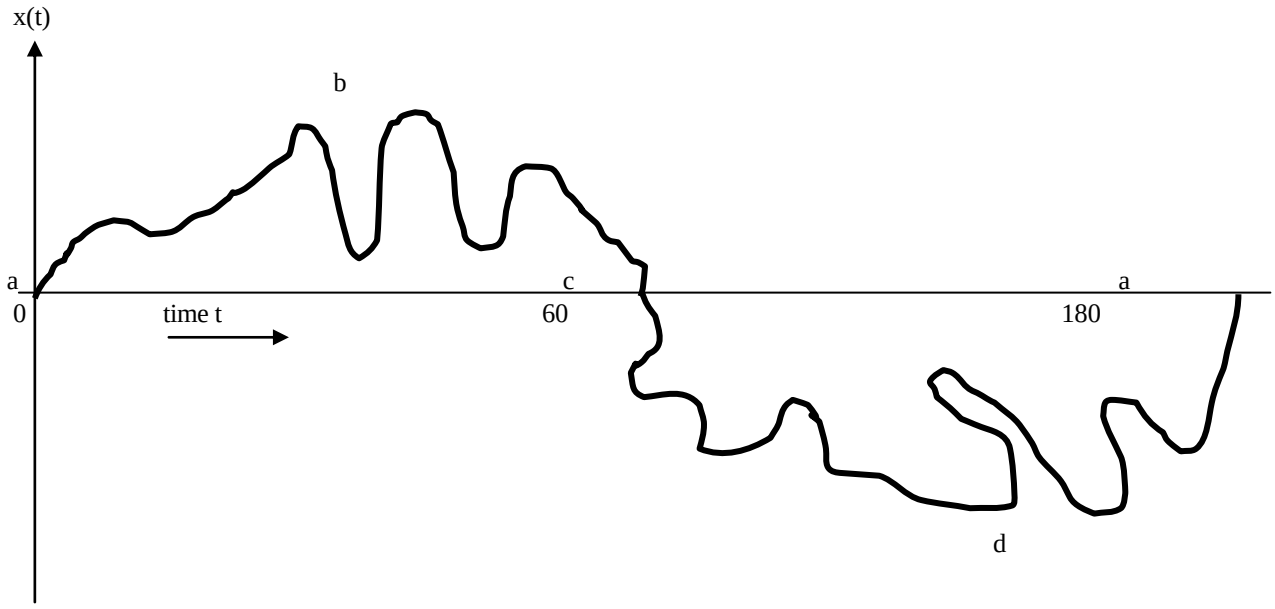

Fig 10. Time Sensing Path Followed By the Runner

V. CONCLUSION

The conclusion of this paper is that the concept of plotting the signal on paper, graph paper or to show in oscilloscope is to mark the amplitude of the signal at different times which gives the shape of signal. When, I applied this theory to the B.Tech. Students, I found that students not only grasped this theory but also solved a number of problems based on this. This paper is an outcome from the teaching experience where the students faced a lot of problems to understand the concept of signals as well as oscillations. This work is an attempt to teach the students step by step construction procedure of signals on the paper or conceptually how to draw in the oscilloscope. This work is an attempt to explore the new and easy theory specially written for signals concept related to the basic signals oscillations. No doubt the future studies will further explore my work in deep. On the basis of this theory, some other signals theory could be developed that will go long to the scientists and students. As no matter is available on the internet/books, hence *I claim that this theory is purely*

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based on my research work/affords and has a bright chance to explore new theory and ideas on this..

VI. ACKNOWLEDGEMENT

I would like to thank to my B.Tech. Pursuing students who posed a lot of questions in the form of doubts and inclined me to think more and more to clarify their complex doubts. What I feel in this context that it is only the students for a teacher who can make a teacher gold from silver. Hence, I acknowledge my students and again I pay special thanks to my students who made me to reach at this stage where I could produce this paper.

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Satyapal Singh is currently pursuing his Ph.D. in Electronics and Communication Engineering at Bhagwant University, Ajmer, and Rajasthan, India. He has 17.5 years of glorious experience of Indian Air Force where he worked in technical field and apart from performing his sincere duties he indigenized one of the direction finders in 1994 and saved Indian currency Rs. 60,000/- per rectification. For this incredible act, he was awarded with cash. He made one of the beacons serviceable in world's toughest hard war-field during Kargil war. He has published four books naming "Electronic Switching", "Mobile and Wireless Communication", "Data Communication Networks" and "Optical Networks" and one book is in press naming "Optical Fiber Communication" – all the books are written for B.Tech. Pursuing students. He received his M.Tech. Degree in Electronics & Communication Engineering from M.D. University, Rohtak, Haryana, India in 2010 and M.Tech. (ALCCS) Degree in Computer Science from IETE, New Delhi, India. Apart from these, he holds MCM(Computer) from University of Pune, India, MMS(Marketing) from University of Pune, India, B.Tech. (ET-AMIETE) from IETE, New Delhi, India, B.Tech. (EC) awarded by Indian Air Force, B.Sc. (PCM) from CCS University, Meerut, UP, India, Diploma (EC) awarded by Indian Air Force, DBM from University of Pune, India and D.Mat.M from NIIRD, Madras (Chennai), India. His main research interests are – Computer Networks, Signals and Systems. Some of the papers are published in international/national journals and conferences. Some of the published papers are "Proof of SP's Unit Step Function With The Help Of Examples"," Proposed Concept of Signals for Unit Step functions", "Proposed Concept of Signals for Ramp Functions", "Proof of SP's Unit Ramp Function With The Help Of Examples". Apart from this, five papers are published at national level. He is a life time member of Institution of Electronics and Telecommunication Engineers (IETE).

Dr.(Lt.) Rajeev Kumar Singh is currently working as Associate Professor in Department of Physics (Head of the Department) at Ajmer Institute of Technology, Ajmer, Rajasthan, India since July 2004 where apart from this he has been provided with designations such as – Officer In-charge examination, Chief Hostel Warden & Member of Discipline Committee. He is a multiskilled personality since 1996 in the fields of industry & advertising Companies (as Marketing Manager) & Institution (as faculty). He was awarded Lieutenant rank in NCC (Army Wing). He received his Ph.D. degree from L.N. Mithila University, Darbhanga, Bihar, India and M.Sc.(Physics) from A.N. College, Bodhgaya University Patna, Bihar, India.

Suruchi Rawat is currently pursuing B.Tech. (EEE) from ABES Engineering College, Ghaziabad, UP, India affiliated to MTU, Noida, India. She scored 96.4% in Secondary School in 2009 and 91.4% in Senior Secondary School in 2011. She is perpetually scoring more than 70% in her B.Tech. Semester exams. She holds first position in the school since class first till date. She is awarded many times for participation in different types of programs such as academic, cultural, debates, sports etc. She is developing her career in engineering field and hence her interest made her to participate in developing this research paper.