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Proof of Sp's Unit Ramp Function with the Help of Examples

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Abstract*— Up-till now two main theories were developed by the author/s. This paper is dedicated to prove the theory developed earlier on paper naming "PROPOSED CONCEPT OF SIGNALS FOR RAMP FUNCTIONS". In the earlier research papers as mentioned in reference at serials numbers 4 through 9 at the last of this paper, the author/s discussed SP's proposed concept of elementary signals for Unit Step and Unit Ramp Functions. These elementary signals play a vital role in the study of signals. These elementary signals serve as basic building blocks for the construction of more complex signals. In fact, these elementary signals may be used to model a large number of signals which occur in nature. Based on the concept developed, in this paper some examples are solved to prove the theory or more clearly SP's theory for Ramp signals. Hence, it has been named as "Proof of SP's Unit Ramp Function with the Help of Examples".

***Index Terms*— 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

SP's angle theory states that the elementary signals such as unit step and ramp functions can be represented by angles too. To understand this, first the existing theory [1 through 3][10 through 16] for ramp functions is briefly narrated and then SP's unit ramp function is explained[4][6][8] in a nut-shell. SP's angle theory says that the Ramp functions can be defined with the help of one 45 degree angle in three steps which gives a new & better idea to understand the Unit Ramp Function. Apart from this, when one is asked to construct a shape from a given equation, then normally he/she is provided with an equation that usually contains basic or elementary signals. Most of the students and engineers may be unaware to what to do for a given equation even after learning the existing theory. For this, I have developed "Concept of Angles" [4][6][8] theory that may be helpful in constructing the shapes from the given equation and in understanding the basic signals. Let us take the Ramp signal function to explore the concept of angles.

II. BRIEF DISCUSSION OF EXISTING DEFINITION/THEORY AND CONCEPT DEVELOPED

Existing theory - The existing theory states that the signal will start from time zero and instantly will take a slant shape[1 through 3][10 through 16] and depending upon given time characteristics (i.e. either positive or negative, here positive) the signal will follow the straight slant path either towards right or left, here towards right. Thus, the ramp function r(t) is a type of elementary function which exists only for positive side and is zero for negative. The continuous-time ramp function is denoted by r(t) and it is mathematically expressed as –

$$r(t) = \begin{cases} t, \text{ if } t >= 0 \\ 0, \text{ otherwise (that is, for } t < 0) \end{cases}$$

Figure 1 shows that there is actually one 45 degree shift in unit ramp function, it is explained with the help of first by taking a unit ramp function r(t).

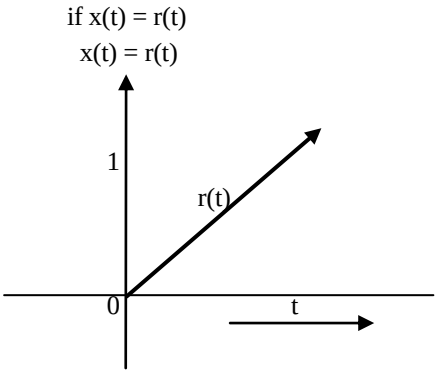

Fig 1. Continuous-Time U*nit Ramp Function* Based On Existing Theory

SP's concept - For this case, function r(t) can be represented in terms of angles as shown below –

$$r(t) = \begin{cases} 0, \text{ when } t < 0 \\ t, 45^0 \text{ anticlockwise w.r.t. x axis \& at } t = 0 \end{cases}$$

This representation is nothing but the *SP's* U*nit Ramp Function* [4][6][8]. To prove this concept or theory, some examples are solved. These solutions are helpful for the

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students as well as for the technocrats. Thus U*nit Ramp Function* r(t) signal takes one 45 degree shift – it shifts in anticlockwise direction and finally extend at this angle upto infinity. Hence, plotting of r(t) by using angles can be shown as in figure 2. This plot has total three steps, hence I will call it is a "*STEP BY STEP*" plot of unit ramp function. The steps can be referred in [6] [8].

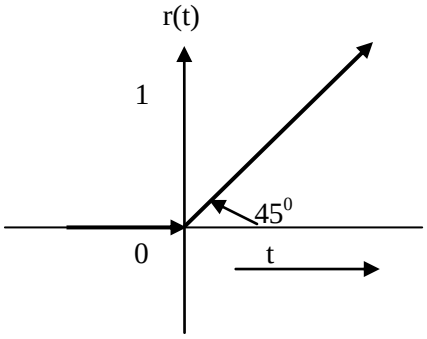

Fig 2. Sketching Of Function R (T) Using Angle Theory, Step 3.

Similarly, r (-t), -r(t) and –r(-t) can be plotted. For more details, refer [4][6][8].

III. ANALYSIS OF THE THEORY DEVELOPED THROUGH EXAMPLES

Let us consider some examples to prove the concept developed. For this, let us take examples based on signal r(t).

Example 1. DRAWING OF r(t-2)

Solution: The existing theory says r(t-2) can be shown below -

$$r(t-2) = \begin{cases} t, \text{ if } t >= 2 \\ 0, \text{ otherwise (that is, for } t < 2) \end{cases}$$

And it can be drawn using existing theory as below –

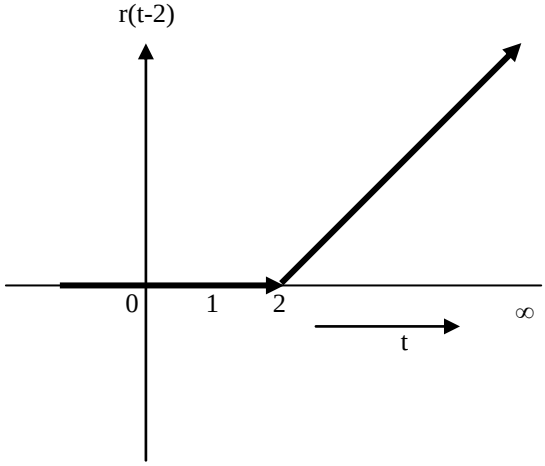

Fig 3. Unit Ramp Function R (T-2) Using Existing Theory

Drawing of r (t-2) considering SP's theory –

Step 1. First assume that, in idle case when no signal is there, then every signal is assumed to be present on x-axis with zero amplitude. Hence, now for signal r(t-2) which has positive time t, the signal line comes from negative infinity to t = 2 as shown in figure 4.

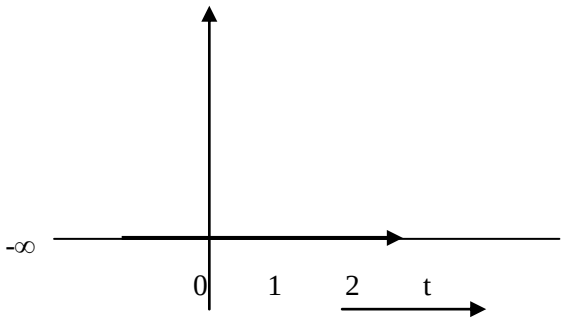

Fig 4. Plot of R (T-2) Under No Signal Condition

Step 2. As soon as the signal r(t-2) comes/appears then the signal instantly takes a 45 degree shift at t = 2 in anticlockwise direction with respect to x-axis and takes one straight slanted line in first quadrant i.e. takes one slant straight line in between x and y axis. This situation is shown in figure 5.

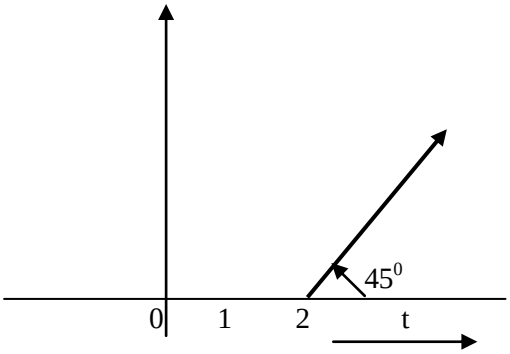

Fig 5. Plot Of R (T-2) As Soon As Signal Appears At T = 2.

Step 3. Now, mix all the above steps and we get a new well defined diagram. Lastly, this slant straight line extends upto infinity at an angle of 45^0 in first quadrant and in between x and y-axis. The whole diagram can be shown as below for one 45^0 shifts. This figure clearly explains that it has one 45 degree angle. This is shown in figure 6. This figure explains step by step following mathematical expression.

$$r(t-2) = \begin{cases} 0, \text{ when } t <= 2 \\ t, 45^0 \text{ anticlockwise w.r.t. x axis \& at } t = 2 \end{cases}$$

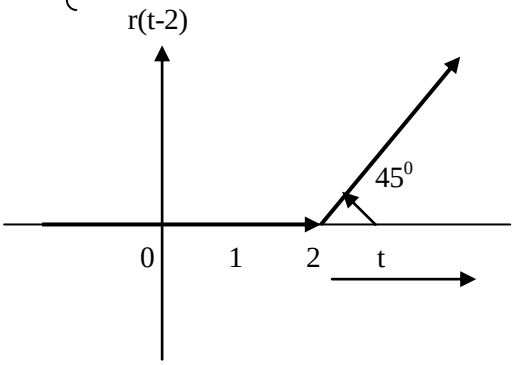

Fig 6. Step By Step Plot of R (T-2) After Mixing Each Step

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Example 2. DRAWING OF -r(t-2)

Solution: The existing theory says -r(t-2) can be shown as below –

$$-r(t-2) = \begin{cases} -t, \text{ if } t >= 2 \\ 0, \text{ otherwise (that is, for } t < 2) \end{cases}$$

And it can be drawn using existing theory as below -

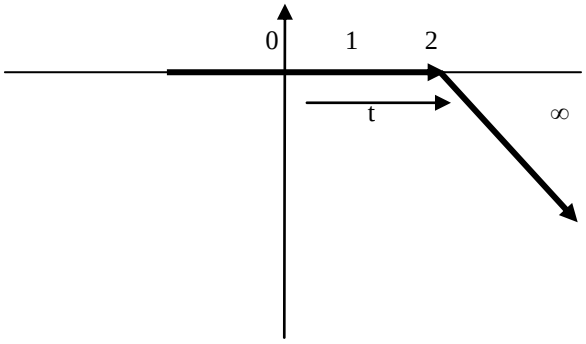

Fig 7. Unit Ramp Function -R (T-2) Using Existing Theory.

Drawing of -r (t-2) considering SP's concept –

Step 1. First assume that, in idle case when no signal is there, then every signal is assumed to be present on x-axis with zero amplitude. Hence, now for signal -r(t-2) which has positive time t, the signal line comes from negative infinity to t = 2 as shown in figure 8.

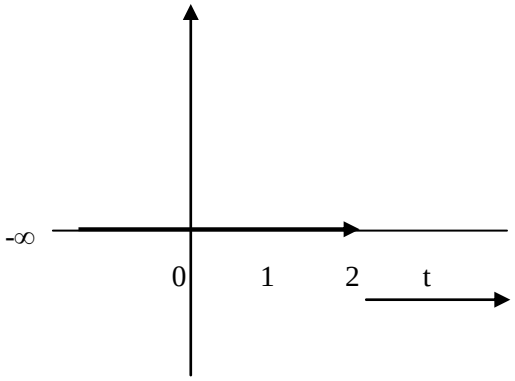

Fig 8. Plot of -R (T-2) Under No Signal Condition.

Step 2. As soon as the signal -r(t-2) comes/appears then the signal takes a 45 degree shift at t = 2 in clockwise direction with respect to x-axis and takes one straight slanted line in fourth quadrant i.e. takes one slant straight line in between x and y axis. This situation is shown in figure 9.

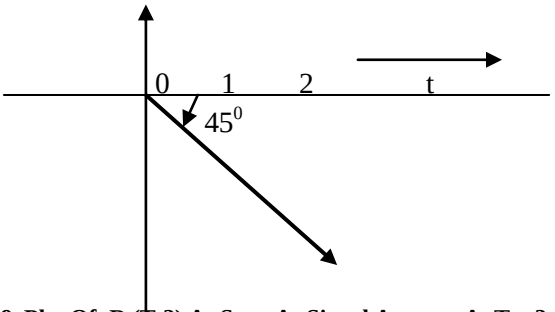

Fig 9. Plot Of -R (T-2) As Soon As Signal Appears At T = 2.

Step 3. Now, mix all the above steps and we get a new well defined diagram. Lastly, this slant straight line extends upto infinity at an angle of -45^0 in fourth quadrant and in between x and y-axis. The whole diagram can be shown as below for one 45^0 shifts. This figure clearly explains that it has one 45 degree angle. This is shown in figure 10. This figure explains step by step following mathematical expression.

$$-r(t-2) = \begin{cases} 0, \text{ when } t <= 2 \\ -t, 45^0 \text{ clockwise w.r.t. x axis \& at } t = 2 \end{cases}$$

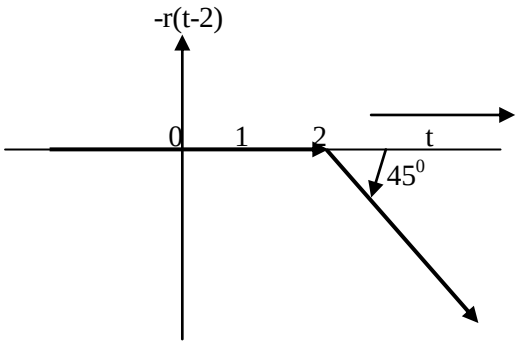

Fig 10. Step By Step Plot Of -R(T-2) After Mixing Each Step

Similarly, considering all the three steps, some example will be plotted without explaining each and every step.

Example 3. Sketch the shape of the given equation –

r(t) – 2r(t-3) - r(t-6)

Solution –

The solution is given below by keeping the given theory in the previous sections –

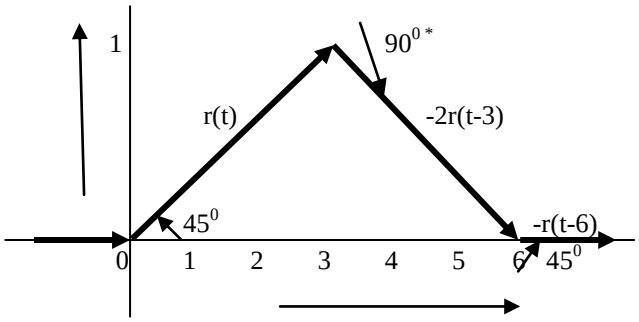

Fig 11. Step By Step Plot Of R (T) – 2r (T-3) - R (T-6) After Mixing Each Step. *(Concept of 2r Having 90 Degree To Be Discussed Later)

The solution is given above by keeping the given theory in the previous sections –

Example 4. Sketch the shape of the given equation –

r (t) - r(t-3) - r(t-6) + r(t-9)

Solution –

The solution is given below by keeping the given theory in the previous sections –

The solution is given below (figure 12) by keeping the given theory in the previous sections –

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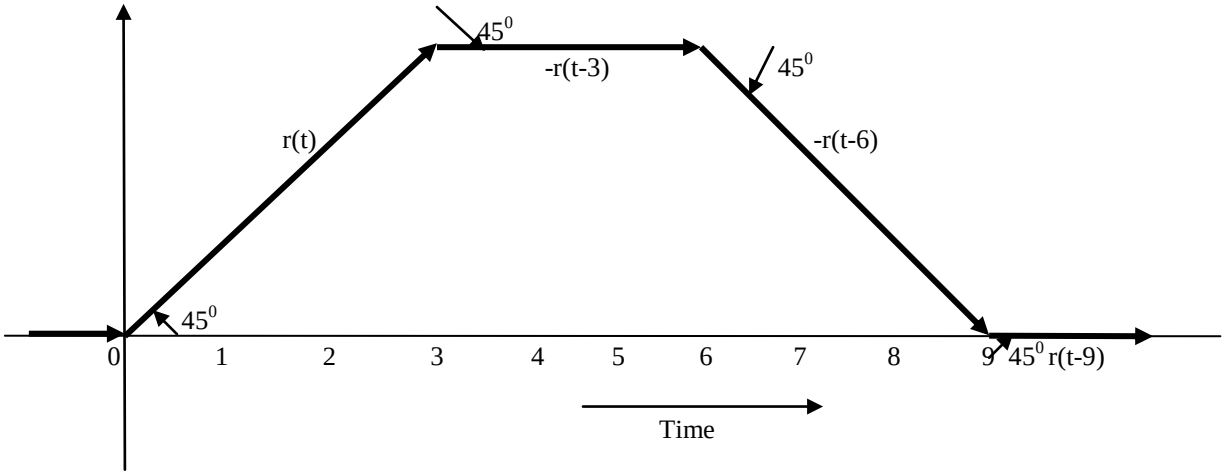

Fig 12. Step By Step Plot Of R (T) – R (T-3) - R (T-6) + R (T-9) After Mixing Each Step

Example 5. Sketch the shape of the given equation –

r(t) - r(t-3) + r(t-7) – r(t-9)

Solution –

The solution is given below by keeping the given theory in the previous sections –

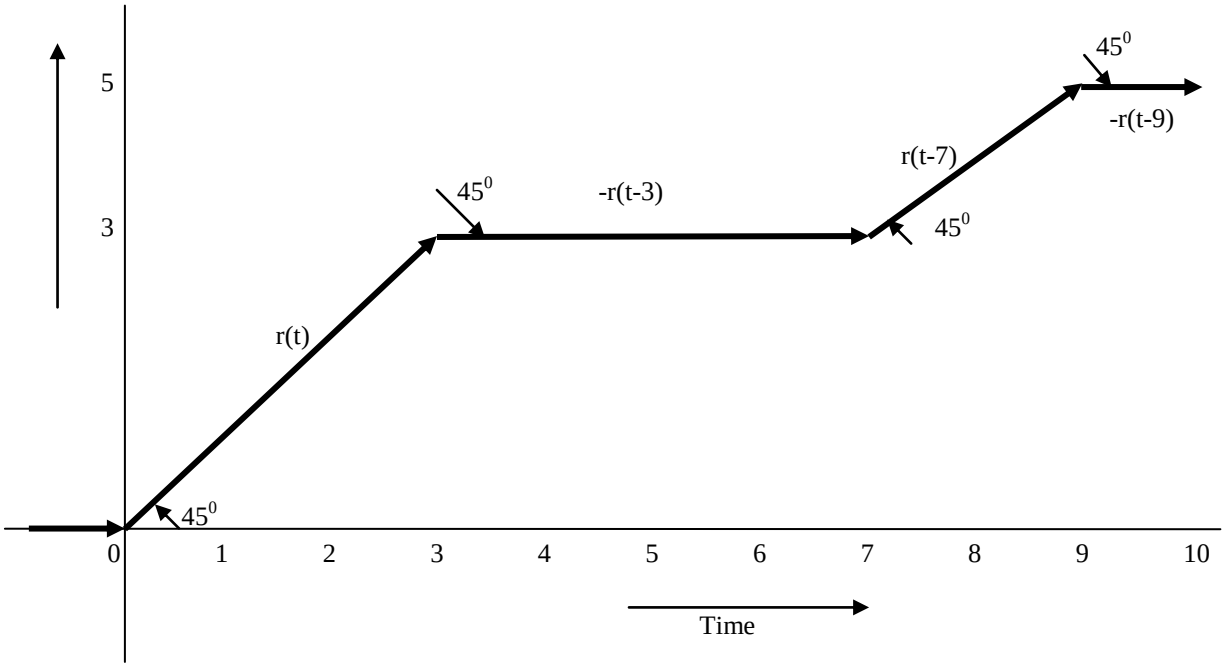

Fig 13. Step By Step Plot Of R (T) – R (T-3) + R (T-7) - R (T-9) After Mixing Each Step.

Example 6. Sketch the shape of the given equation –

r(t-2) - r(t-3) + r(t-4) - r(t-5)

Solution –

The solution is given below by keeping the given theory in the previous sections –

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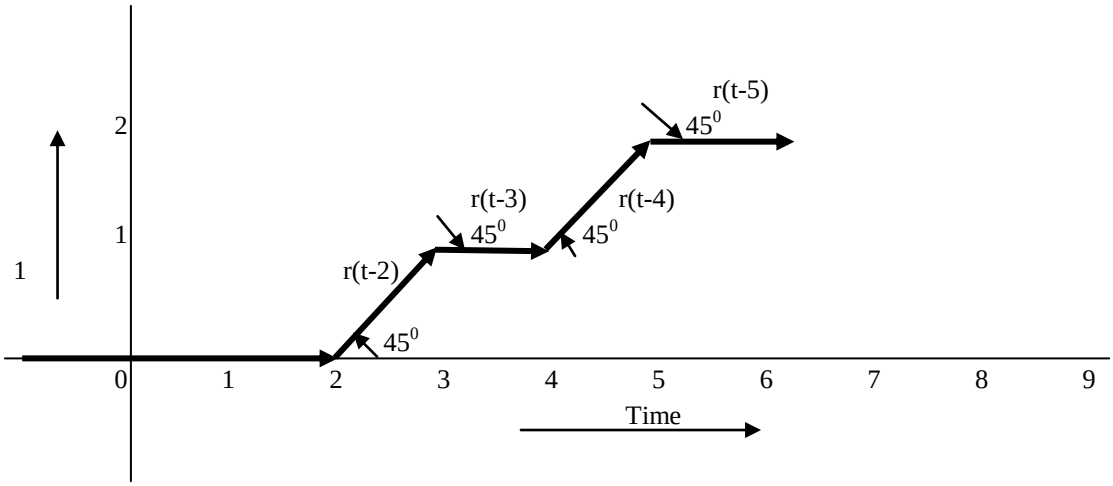

Fig 14. Step By Step Plot Of R (T-2) - R (T-3) + R (T-4) - R (T-5) After Mixing Each Step

IV. CONCLUSION

When, I applied this theory to the B.Tech. (Subject: Signals and Systems) students, I found 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 and my related research papers. The students faced a lot of problems to understand the ramp function numerical problems. This work is an attempt to teach the students step by step construction procedure of ramp signal functions and this work has an attempt to explore the new and easy theory specially written for ramp signals related to the basic signal functions. As no matter is available on the internet/books, hence I claim that this theory/analysis is purely based on my research work/affords.

V. FUTURE SCOPE

No doubt, the future studies will further explore my work in deep. On the basis of this theory, what I see, some other signals could be developed that will go long to the scientists and students. My present and previous papers have bright chances to explore new theory and ideas on this subject. I expect, computer coding may be enhanced in days to come using this theory, how? will be the part of new research and researchers.

VI. ACKNOWLEDGEMENT

Normally, those who pressurize to invent or think are paid due thanks and regards, hence I would like to thank to 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 which is now in your hands.

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AUTHOR'S PROFILE

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, and 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 "Concept of and Plot of Signals on Paper and in Oscilloscope", Proposed Concept of Signals for Unit Step functions, Proposed Concept of Signals for Ramp Functions. 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 multi skilled 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 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.