4. Research, Design & Methodology:

The subject of the study of the present work is connected with all the students of Acoustic Engineering, Physics, Music, Musicology, music teachers, musical institutions, performing artists, research scholars alike as it deals with the study of both the art and the science of the raaga formation. The science of music deals with the general laws of the sound, frequencies of various harmonic intervals, mathematical representation of swara patterns of the raagas in terms of ratios of frequencies with which they are related with the tonic swara 'Sa', the harmonic relationship of various swaras with the tonic swara Sa and its effect on the consonance & dissonance level etc. The art of music, however, deals with the aesthetic aspects i.e the psychological appeal of the sequence of the particular group of swaras of the raaga, which are repeated again and again in the raaga performance, on the minds of the listener etc. The art of music also deals with psychological appeal of various Raagas because of which they are performed at various times of the day and night to create a particular impact on the human mind for evoking various emotional feelings etc. Both of these aspects have been dealt and deliberated upon in the present work.

Also, the existing data base of all the popular Raagas of Hindustani & Carnatic music has been studied and analysed in the present study and the principles of inverse relationship of Swaras, as discussed in the later chapters, have been applied on them to get the inverse swara patterns of those Raagas. Such inverse patterns of Raagas have then been compared with the original data base of Raagas and the possibility of the correlations between the two set of swara patterns had been seen by comparing the inverse pattern of various Raagas with all the existing Raagas patterns. The inversion of Swara pattern and the comparison of these inverted patterns with their original patterns were done with the help of the computers for avoiding man made mistakes etc. as the data was too huge. The data base & the comparative statement have been made as part of the research work & have been dealt in detail in the concerned chapters.

Besides this, the traditional 'bandishes (cf0n'k) ' of few of the very popular Raagas have been selected and the above principals of inverse relationships have been applied on them to get the new swara patterns, which had then been got performed and got recorded which will also be presented to the experts for ascertaining whether

the inverse swara patterns of Raagas so formed do make some aesthetic appeal etc. or not. That way the research work is exploratory in nature as it attempts to see the possibility of existence of new Raagas and also to find and establish the new relationships in various established Raagas. The results also have been discussed in the concerned chapters, which would be equally of interest to all the music fraternity including students, teachers, performing artists of music, musicologists, and research scholars etc. as mentioned above.

My contribution;

The exposure of the researcher to both the fields of Physics and Music has made it possible to combine the two spheres of knowledge and come to some unique and valuable conclusions.The researcher had a fair idea of both the subjects as he had passed his Master degree of Engineering in the subject of Electronics Engineering in 1982 from University of Roorkee (UP, now Uttarakhand) and Master of Arts degree in Vocal Music in 2006 from Rabindra Bharti University, Kolkata. Also, while in Delhi, Mumbai and in West Bengal, the researcher had the opportunity to attend to the live in concerts of many exponents of Indian classical music, Carnatic music and Western music etc. The researcher also had the opportunity to attend to the various seminars on the subject of raaga music and Musicology in Delhi, Mumbai, Siliguri, West Bengal and Kolkata. This had given him an opportunity to interact with many renowned personalities on the subject including Dr.S.A.S.Durga, a world renowned musicologist from Madras, Padma Bhushan, Prof. R.C.Mehta, ex-president of Indian Musicology Society, Dr.Vidya Dhar Vyas, ex-Principal, Department of Music, University of Mumbai, Dr.Ashok Ranade, a world renowned authority on Indian Musicology & Music and also the performing artists on Raaga music including Sangeet Martand Pt. Jasraj and others as already explained above. During the various interactions with the above personalities the subject of the present study was discussed in detail. Barring Pt.Shiv Kumar Sharma, all the other scholars were very positive of the idea of exploring the existence of the Inverse Raaga patterns. Pt. Sharma too, though had agreed on the idea of the present work in principle but was of the view that since, there are many established raagas already for which one will take more than a life time to master, there is hardly any need for further exploration of the new Raagas, even if they were found to be melodious and having the independent existence etc. The concept of inverse relationship of raagas was also presented by the researcher in an International seminar at National Center of Performing Arts, Mumbai

in January, 2010, wherein it was accepted and appreciated by the audience, which included Padma Bhushan,Prof. R.C.Mehta, Dr.S.A.S.Durga, Ms.Shubha Mudgal, Ud Zakir Hussein, Ms.Anita Sai Ram, Pt.Arvind Parikh, Prof Richards Widdess (Professor of Musicology, University of London) , Prof.Wim Van der Meer, associate professor, University of Amsterdam and many others in the field of music.

Since, the researcher had the opportunity to get the exposure on both the scientific and artistic aspects of Indian music, it was comparatively easier for him to combine the knowledge of both the two different looking fields of Physics & Music and come out with the present concept of the study, which is unique and revolutionary in nature. Also the work done in the present study has not been done anywhere in India or abroad so far, which is evident from the non availability of virtually any literature on the subject. Since the subject is new, it was very difficult for the researcher to get it across to the performing artists, who generally had not been sufficiently exposed to the scientific side of the music and had a particular mind set in which they had been keeping the basic design of their performances etc. However, the musicologists readily appreciated and accepted the idea, this being totally different and new. Also, they had confirmed that it has not been dealt and deliberated so far anywhere in the world.

The entire writing work of the study has also been done by the researcher himself. However, at places where the contents had been taken from the other sources, published or unpublished and reproduced in the work, the same has been done only to authenticate the statements made in the study and to explain a specific point of view. Also, every such reproduction has adequately & properly been acknowledged in the reference section.

The data base of all the existing raagas has been made by using MS Access, an application of MS Word on Window 7 environment, on a Personal Computer. Though the few of inverse raagas patterns have been derived manually by the researcher using the above discussed principles, but mostly it was done with the help of computers. Also the matching of those inverse raaga patterns with the existing raagas has been done on the Personal Computer with the help of a program in C++. This has not only made the process of matching faster but, had also made it possible to avoid manual mistakes to a very large extent. Because of this, the researcher feels that the results drawn in the study had been sufficiently reliable.

The entire work of the present study has been done by researcher under the close guidance of his guide, Dr Rakesh J.Mahisuri, of Dept. of Instrumental Music (Sitar-Violin), Faculty of Performing Arts, The Maharaja Sayajirao University of Baroda, Vadodara.