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Possible Configurations and Coupler Curves of Eight Link Gear Variable Topology Mechanism in Phase III Operating Condition

H. M. Naveen[1], Shrinivas S. Balli[2] and Umesh M. Daivagna[3]

[1]Assistant Professor, Department of Mechanical Engineering, RYM Engineering College, Ballari, Karnataka, India
[2]Professor & Head, Department of Mechanical Engineering, Basaveshwar Engineering College, Bagalkot, Karnataka, India
[3]Professor, Department of Mechanical Engineering, Ballari Institute of Technology, Ballari, Karnataka, India

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Abstract- *The paper presents possible configurations that can occur in eight link gear mechanism with two degrees of freedom. The present study is an outlook to the synthesis process of eight link gear mechanism with variable topology. The configurations in the present scenario express that an eight link gear mechanism can be arranged to obtain a coupler curve which serve as the basis of the paper. Based on this aspect the designer can think of synthesizing a particular configuration to meet the desired requirement. Coupler curves appearing in every configuration draw the attention of a designer to focus on the application aspects of the mechanism. The overview of the possible configurations is carried out in Linkage Software.*

Key Words: Variable Topology Mechanism, Configurations, Coupler Curves

1. INTRODUCTION

Dimensional synthesis of mechanism is a prime part of design process. Increase in number of links and degree of freedom in a mechanism complicates the process of synthesis. Variable topology is one of the methods considered in synthesis of such complicated mechanisms. In the paper possible configurations and respective coupler curves of eight link gear mechanism, with two degrees of freedom are considered for the study. Kinematic synthesis can be considered to perform the tasks like motion, path and function generation which may be taken into consideration for various applications. The synthesis starts with fundamental concept on mechanism requirement, number of links required and type of mechanism to be designed. Once this is decided, further process is to have a rough idea of the desired mechanism and determine the degree of freedom. Determination of degree of freedom is of prime importance as the input given to the mechanism to operate, depends mainly on the degree of freedom.

This paragraph sums up the work and literature carried out on variable topology mechanisms. Balli and Chand [1] worked on five bar mechanism using an analytical method for motion between extreme positions with variable topology. Balli and Chand [2] synthesized five bar motion and path generation for motion between extreme positions.

In order to synthesize a variable topology mechanism for motion between two dead centers, Balli and Chand [3] have suggested an analytical method. Gadad *et al.,* [4] worked on seven link mechanism of variable topology for function generation using dyad and triad synthesis. Daivagna and Balli [5] synthesized on off-set five-bar slider with variable topology. Daivagna and Balli [6] designed a mechanism with variable topology for seven-bar slider. Daivagna and Balli [7] synthesized a five-bar slider mechanism for two positions with variable topology. Prashant and Balli [8] reviewed on mechanisms with variable topology. A mechanism is a mechanical device that has the purpose of transferring the motion or force from an input link to an output link [9]. H. M. Naveen *et al.,* [10] dealt with synthesis of eight link gear mechanism for motion generation. H. M. Naveen *et al.,* [11] dealt with synthesis of In-Line Ten Link Gear Slider Mechanism of Variable Topology type. The possible types of solutions are discussed in the following paragraphs with the aid of Computer Aided Design (CAD) program called Linkage [13].

2. POSSIBLE CONFIGURATIONS OF EIGHT LINK GEAR MECHANISM

The purpose of a mechanism is not only to transfer motion and force but also to guide a part along a particular path. The paths generated by points on a connecting rod or coupler can often achieve the complex motion. The trace of a point is the path that the point follows as the mechanism moves through its cycle. The path traced by any point on the coupler is termed as coupler curve [12]. The possible configurations under the study generate the coupler curve designated under two input motions. This is because an eight link gear mechanism is two degrees of freedom mechanism and hence, requires two inputs to run the mechanism. Basically these configurations could be run under the two Phases of variable topology by fixing a link adjacent to the ground temporarily in each of the Phases. In order to get the desired coupler

curve, the possible configurations of variable topology mechanisms can be made to operate under Phase III operating condition where in which both the cranks work at the same time providing input motion to the mechanism. These Phases are discussed in the following paragraphs.

Phases in Variable Topology Mechanisms

As expressed in the earlier paragraphs variable topology method consists of various Phases namely, Phase I & Phase II. In connection with these two Phases an additional Phase which is named as Phase III is introduced in the paper. The importance and the activities that are going to be conducted these Phases are explained in brief.

Activities in Phase I

In this Phase a link adjacent to the ground in the variable topology mechanism will be identified to fix it temporarily. This condition of fixing the link temporarily is implemented in the process of synthesizing the mechanism as well as in operating the mechanism. The synthesis process in this Phase involves prescribing some parameters, allowing for free choices of some parameters and the determining the unknowns especially the link lengths.

Operation of the mechanism in this Phase involves temporary fixing of the identified link to be fixed temporarily and operating the mechanism with this predefined condition. In order to simplify all the process happening in the Phase, input crank will be identified as the Temporary Link.

Activities in Phase II

In this Phase also a link adjacent to the ground in the variable topology mechanism will be identified to fix it temporarily. This condition of fixing the link temporarily is implemented in the process of synthesizing the mechanism as well as in operating the mechanism as followed in earlier Phase. In addition to this, the temporary link which was fixed temporarily in Phase I will be released to move and the mechanism occupies a new position which stands to be the initial position for Phase II.

The synthesis process in this Phase also involves prescribing some parameters, allowing for free choices of some parameters and then determining the unknowns using the determined parameters of Phase I. The values obtained in Phase I will be retained in Phase II synthesis process. Once all the link lengths of the mechanism are obtained, they will be utilized to construct the mechanism.

Operation of the mechanism in this Phase involves fixing of the identified link to be fixed temporarily in the ending position of Phase I and releasing the previously fixed temporary link of Phase I to move. Mechanism will be operated with this defined condition.

Activities in Phase III

Phase III in variable topology mechanism focuses on only the operating condition of the mechanism rather than the synthesis process. Since the parameters are determined and mechanism is constructed, further process is to operate the mechanism in each of its Phases with one input respectively in Phase I & Phase II. Phase III operating condition defines that the same mechanism could be made to operate with both the input cranks operating at the same time which serves the other possibilities of the mechanism design. In summation, operation of mechanism follows through three different positions of operating conditions. Table 1 provides the summary of mechanism operation in various Phases of variable topology.

Table 1 Summary of Mechanism Operation in various Phases of Variable Topology

Mechanism Operation	Phase I	Phase II	Phase III
Starting Position	Position 1	Position 2	All Positions
Ending Position	Position 2	Position 3	All Positions
Input Crank Operation	One Crank	One Crank	Two Cranks

Temporarily Fixed Link	One	One	Nil
Number of Inputs Required	One	One	Two

The possible configurations and their respective coupler curves with applications are discussed in the following paragraphs.

2.1 Configuration I

The eight link gear mechanism in configuration I, is shown in Fig.1. This configuration comprises of pair of gears arranged at the top and the two input cranks are made to operate. This operation generates an EGG shaped coupler curve which finds much application in industrial sector. Different coupler curves in WATER DROP shapes are depicted in Fig.1

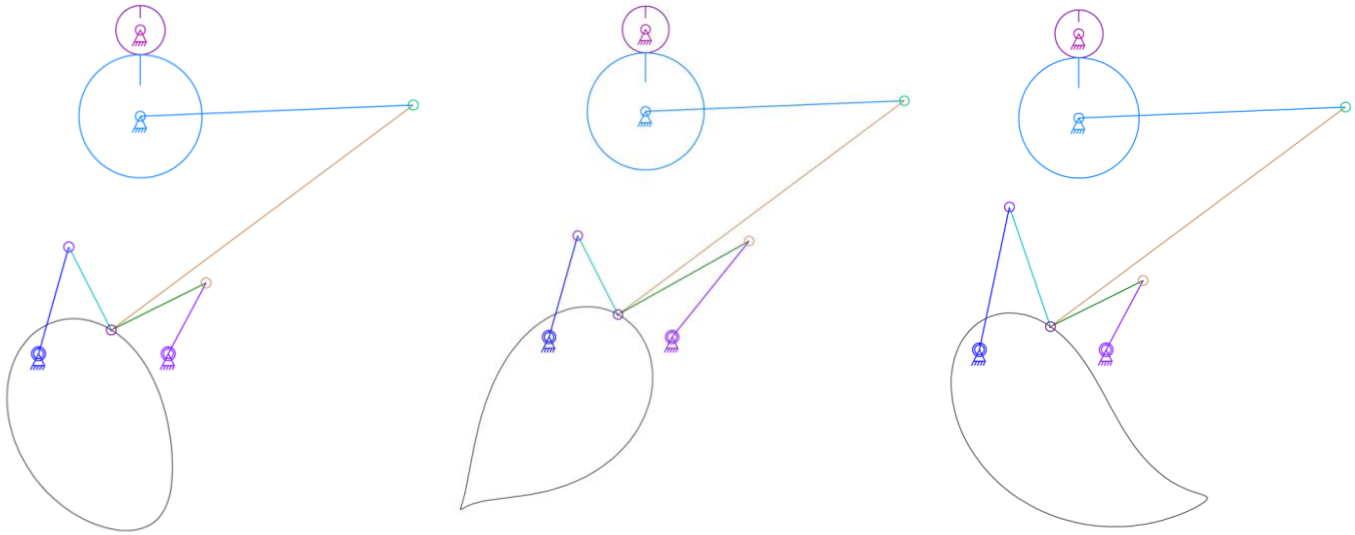

Fig. 1 Eight Link Gear Mechanism in Configuration I and Possible Coupler Curves

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise. Change in crank lengths and coupler lengths provide wide range of curves which serve the purpose of various applications.

Applications: Gold Pendent Cutting, Wood Carving, Soap Cutting, Chocolates Cutting and so on.

2.2 Configuration II

The eight link gear mechanism in configuration II is shown in Fig.2. This configuration comprises of pair of gears arranged at the top which resembles the earlier discussed configuration I, except the couplers occupying a different position. The two input cranks are made to operate and this operation generates a BEAN shaped coupler curve which finds much application in walking leg mechanism. With slight variation in lengths of couplers the mechanism is able to depict SHOE SOLE shaped coupler curve.

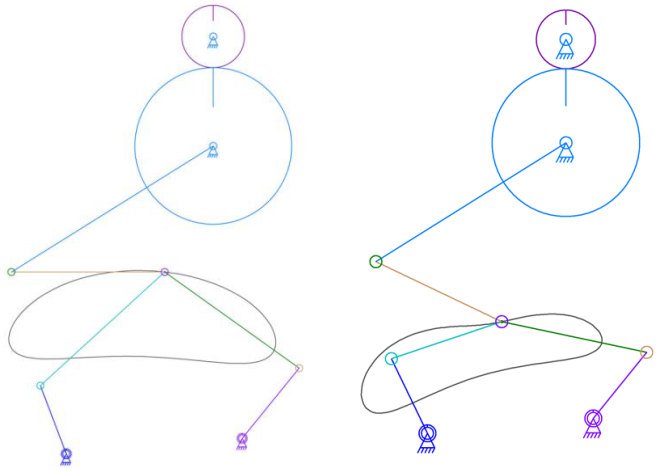

Fig. 2 Eight Link Gear Mechanism in Configuration II and Possible Coupler Curves

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise direction.
Applications: Walking Leg Mechanism, Shoe and Slipper Sole Cutting, Biscuits Cutting and so on.

2.3 Configuration III

The eight link gear mechanism in configuration III is shown in Fig.3. This configuration comprises of pair of gears arranged at the right corner of the mechanism. The couplers occupy almost the same position as discussed in configuration I. The two input cranks are made to operate and this operation generates a number EIGHT (8) shaped coupler curve which finds much application.

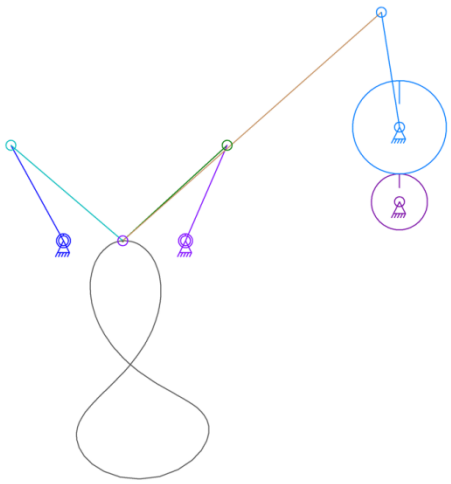

Fig. 3 Eight Link Gear Mechanism in Configuration III and Possible Coupler Curve

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise direction.

Applications: Drawing, Painting, Ironing, Washing, Wiping and so on.

2.4 Configuration IV

The eight link gear mechanism in configuration IV is shown in Fig.4. This configuration comprises of pair of gears arranged at the right corner of the mechanism which is similar to configuration III. The couplers occupy almost the same position as discussed in configuration I. The two input cranks are made to operate and this operation generates a CIRCLE shaped coupler curve which finds much application.

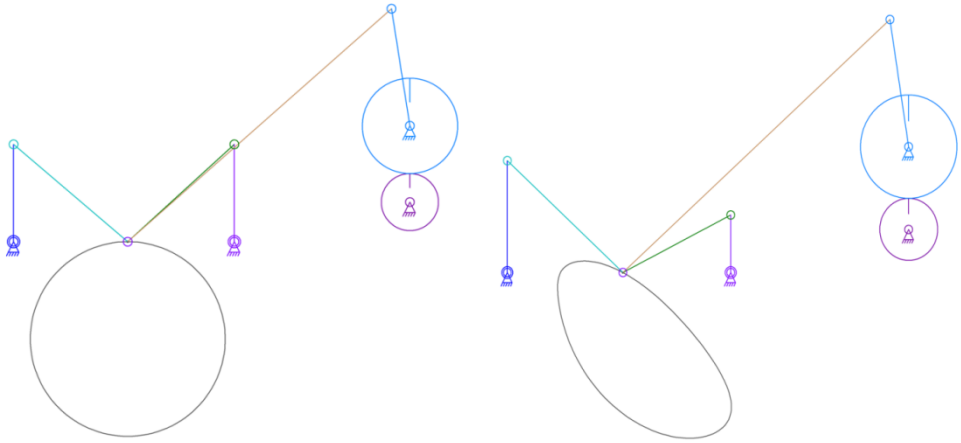

Fig. 4 Eight Link Gear Mechanism in Configuration IV and Possible Coupler Curves

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise direction. Change in crank lengths provide an alternate shape of curve which is shown in Fig.4.

Applications: Glass Cutting for Spectacles, Plates Cutting, Pebbles Cutting and so on.

2.5 Configuration V

The eight link gear mechanism in configuration V is shown in Fig.5. This configuration comprises of pair of gears arranged at the right corner of the mechanism which is similar to configuration III. The couplers occupy almost the same position as discussed in configuration I. The two input cranks are made to operate and this operation generates an OVEL shaped coupler curve which finds much application.

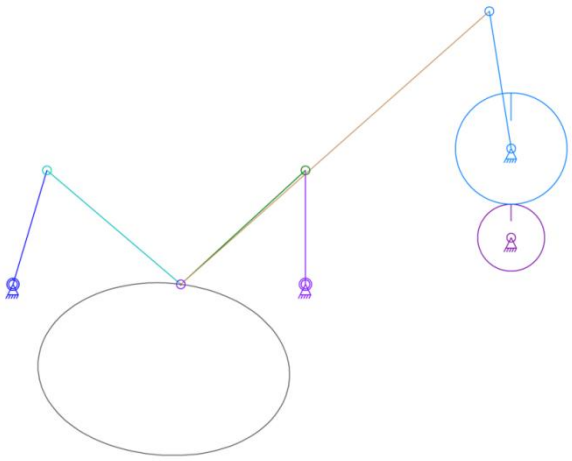

Fig. 5 Eight Link Gear Mechanism in Configuration V and Possible Coupler Curve

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise direction.

Applications: Soap Cutting, Candy Cutting, Stone Cutting and so on.

2.6 Configuration VI

The eight link gear mechanism in configuration VI is shown in Fig.6. This configuration comprises of pair of gears arranged at the right corner of the mechanism which is similar to configuration III. The couplers occupy the horizontal

position. The two input cranks are made to operate and this operation generates a CIRCLE shaped coupler curve which finds much application.

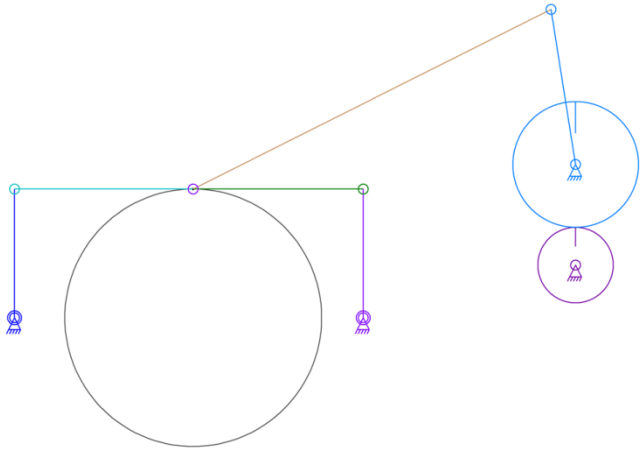

Fig. 6 Eight Link Gear Mechanism in Configuration VI and Possible Coupler Curve

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise direction.

Applications: Mirror Cutting, Sheet Metal Cutting, Winding Operation and so on.

2.7 Configuration VII

The eight link gear mechanism in configuration VII is shown in Fig.7. This configuration comprises of pair of gears arranged at the right corner of the mechanism which is similar to configuration III. The couplers occupy the almost vertical position. The two input cranks are made to operate and this operation generates a CIRCLE shaped coupler curve which finds much application.

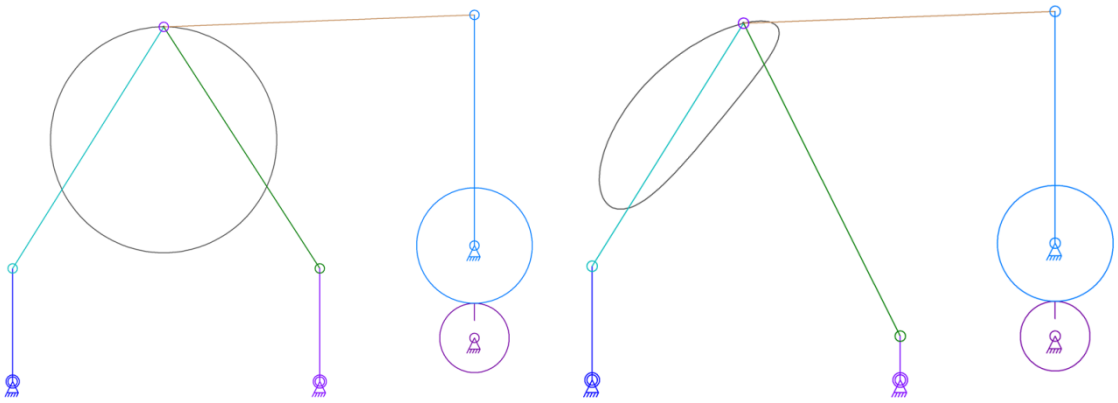

Fig. 7 Eight Link Gear Mechanism in Configuration VII and Possible Coupler Curves

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise direction.

Applications: Cloth Rolling Operation, Sheet Metal Rolling, Dragging Operation and so on.

2.8 Configuration VIII

The eight link gear mechanism in configuration VIII is shown in Fig.8. This configuration comprises of pair of gears arranged at the right corner of the mechanism which is similar to configuration III. The couplers occupy the almost vertical position. The two input cranks are made to operate and this operation generates a WATER DROP shaped coupler curve which finds much application.

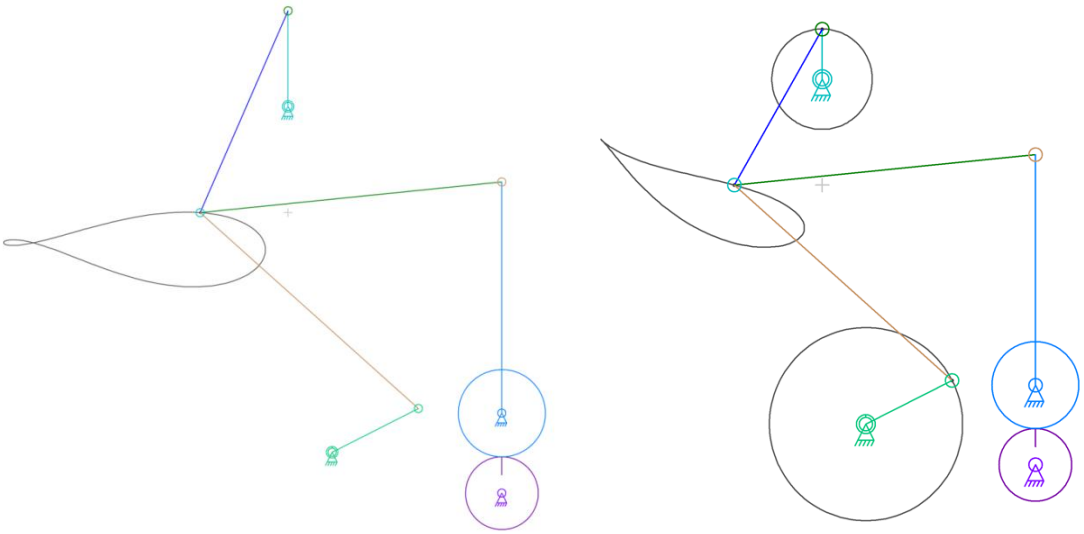

Fig. 8 Eight Link Gear Mechanism in Configuration VIII and Possible Coupler Curves

The cranks of this mechanism act as inputs and pair of gears act as outputs. Rotary motions of cranks can be either clockwise or counter clockwise direction.

Applications: Placing Objects between Conveyers, Pick and Place Operations and so on.

3. Results and Discussion

The present study on coupler curves generated by various configurations, express the behavior of the coupler path point. This can be taken into consideration as design criteria and can be implemented in wide applications. The probable applications of respective configuration curves are already discussed. The possible applications could be utilized in the industrial sector. The explored configurations and coupler curves presented in the paper express that, wide range of possible coupler curves with their applications could be framed by changing the positions of the input link and also by changing the link lengths. Some configurations limit themselves for these types of changes in their orientation and hence, affix to no alternate possibilities with their existing coupler curve.

These coupler curves generated under Phase III operating condition provide an opportunity to delve into the characteristic response of the mechanism considered for synthesis.

4. Conclusion

Study of coupler curve generation in mechanisms using analytical methods as suggested by various authors with the aid of complex algebra and graphical techniques are tedious as compared to software based generation technique. The CAD program Linkage relieves major of the stress involved in analytical techniques. This work demonstrates the usage of the available software to generate coupler curves based on the choice of the designer and also the positions that can be considered on the coupler link in order to satisfy the path generation in mechanisms. Hence, this aspect will be one of the leaping steps in case of coupler curves. Though the literature on coupler curve synthesis is dealt by most of the kinematicians, the authors in this present work have attempted to demonstrate the mode of conduct in coupler curve with the aid of CAD program. This illustration helps in adoption of modern techniques in the era of synthesis of mechanisms.

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BIOGRAPHIES

H. M. Naveen, is serving as Assistant Professor, in Department of Mechanical Engineering, RYM Engineering College, Ballari since 2014.

Dr. Shrinivas S. Balli, has his Doctoral Degree from Allahabad University. He has published more than 22 Research Articles in International Journals/Conferences. He has Academic and Research experience of 30 years and currently serving as Professor and Head, Mechanical Engineering, BEC, Bagalkot.

Dr. Umesh M. Daivagna, has his Doctoral Degree from VTU. He has published many Research Articles in International Journals/Conferences. He has Academic and Research experience of 25 years and currently serving as Professor, Mechanical Engineering, BITM, Ballari.