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TRANSMISSION ANGLES IN SYNTHESIZED EIGHT LINK GEAR MECHANISM OF VARIABLE TOPOLOGY WITH CHARACTERISTIC OUTPUT

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ABSTRACT

The paper presents the occurrence and behavior of Transmission Angles in Synthesized Eight Link Gear Mechanism with Variable Topology. The response of the mechanism is taken into the consideration by plotting the graph with Crank Angle and Transmission Angles. The characteristic output of the mechanism is also studied. The study shows the variations in transmission angles and exhibits the functional aspects of synthesized mechanism within the prescribed limits.

KEYWORDS: Transmission Angles, Eight Link Gear, Variable Topology Mechanism.

1. INTRODUCTION

Every synthesized mechanism is put into action under the influence of force in order to transmit power and motion. Consideration is given to these parameters in design sector. Accompanied with these, transmission angle (μ) in the mechanism is also one of the criteria which draw most of the attention in the field of mechanisms. Transmission angle in a four link mechanism is defined as the angle between the connecting rod and output crank. It may also be defined as an acute angle between the coupler link and output link [1]. In a mechanism, the transmission angle quantifies the force transmission through the mechanism. As the mechanism moves, the transmission angle along with joints, change constantly [2]. Balli and Chand explained that Transmission angle is the angle between the output link and the coupler link in case of a four-bar portion of five-bar variable topology mechanism in each phase [3].

A brief literature review on variable topology mechanisms is carried out. Contributions in the field of mechanism are remembered. Balli and Chand [4] proposed an analytical method to synthesize five bar mechanism with variable topology. The work explains about extreme positions of the mechanism for function generation task. Balli and Chand [5] suggested the complex number and provided it to synthesize the mechanism for motion and path generation tasks with variable topology for movement between extreme positions. Balli and Chand [6] informed an analytical method to synthesize seven link mechanism with variable topology for motion between dead centers. G. M. Gadad, Umesh M. Daivagna and Shrinivas S. Balli [7] worked on seven link mechanism having triad and dyad with variable topology for function generation. Daivagna and Balli [8] synthesized an off-set five link slider mechanism with variable topology. Ren-Chung Soong, Kuei-Shu Hsu and Feng-Tsai Weng [9] suggested gear concept to seven-bar mechanism for mechanical forming presses. Daivagna and Balli [10] worked on a variable topology seven-bar slider mechanism for two dead-center positions. Volken Parlaktas, Eres Soylemez and Engin Tanik [11] suggested an analysis and synthesis method for a geared four-bar mechanism. Daivagna and Balli [12] presented on the synthesis of variable topology mechanism with five-bar slider for finitely separated positions. Prashant and Balli [13] revisited on variable topology method. H. M. Naveen, Shrinivas S. Balli and Umesh M. Daivagna, [14] dealt with synthesis of eight link gear mechanism for motion generation. H. M. Naveen, Shrinivas S. Balli and Umesh M. Daivagna [15] dealt with synthesis of In-Line Ten Link Gear Slider Mechanism of Variable Topology. Prashant and Balli [16] dealt with a seven bar slider for limiting positions using

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variable topology. H. M. Naveen, Shrinivas S. Balli and Umesh M. Daivagna [17] showed the behavior of mechanism using linkage software. H. M. Naveen, Shrinivas S. Balli and Umesh M. Daivagna [18] showed the functional aspects of ten link gear slider mechanism. H. M. Naveen, Shrinivas S. Balli and Umesh M. Daivagna [19] worked on Phase III operating conditions in variable topology mechanism. H. M. Naveen, Shrinivas S. Balli and Umesh M. Daivagna [20] presented alternative approaches in variable topology mechanisms.

2. TRANSMISSION ANGLES IN EIGHT LINK GEAR MECHANISM WITH VARIABLE TOPOLOGY

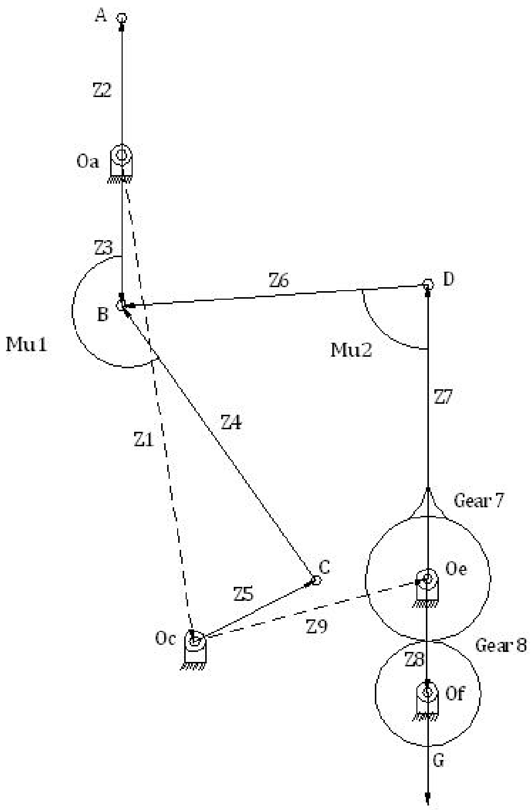

Fig.1 Eight Link Gear Mechanism with Variable Topology

An eight link gear mechanism with variable topology has been illustrated in Fig.1. In this mechanism links O_aA and O_cC are input links. O_aO_c is treated as fixed link. The input links are connected to links AB and CB which in turn are connected to link DB which acts as a coupler. This coupler is connected to gear 7 at point D which is an extension of gear 7 paired to gear 8. The extension O_eD is fixed to gear 7 and rotates along with it. The gear pair is connected by a rigid link O_eO_f. The end points of rigid link act as pivot points on which both the gears rotate. When motion is given to any of the input links, it is transferred to the coupler through links AB and CB to the link O_eD which will rotate according to the desired input motion provided. The vector g (O_fG) represents the rotation of gear 8. When gear 7 rotates with angle γ then gear 8 will rotate with an angle φ in opposite direction with respect to gear 7.

The transmission angles occurring in this mechanism are two in numbers. The angle between the links AB and BC is observed as Transmission Angle Mu1 (μ_1) and in the same sense angle between the links BD and DO_e is termed as Transmission Angle Mu2 (μ_2). The value of these transmission angles constantly change as the mechanism. With variable topology method this mechanism can be made to work in two different Phases to carry

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out various tasks. This can be achieved by making one of the input links to work, keeping another input link fixed temporarily.

Transmission Angles in Eight Link Gear Mechanism with Variable Topology in Phase I

In this phase link O_cC is temporarily fixed and O_aA acts as input link. When the input link O_aA is rotated by θ_{12} = -180^0 CW from the starting position, links AB, BC, BD and DO_e get displaced from the starting position and move until they reach the ending position. Due to this action the transmission angles μ_1 and μ_2 also change their values. The following Table 1 shows the range of transmission angles in Phase I operation of the mechanism. The graph of transmission angles v/s crank angle motion is also plotted.

Table 1 Transmission Angles in Eight Link Gear Mechanism with Variable Topology in Phase I

Input Crank Angle	Transmission Angle µ1	Transmission Angle µ2
0^0	213.57^0	87.47^0
10^0	219.02^0	87.89^0
20^0	224.78^0	87.35^0
30^0	231.81^0	87.77^0
40^0	238.55^0	88.25^0
50^0	244.56^0	89.09^0
60^0	252.31^0	89.55^0
70^0	259.10^0	90.02^0
80^0	265.59^0	90.78^0
90^0	271.85^0	91.55^0
100^0	271.06^0	92.56^0
110^0	270.85^0	93.36^0
120^0	287.16^0	93.94^0
130^0	291.27^0	94.87^0
140^0	293.41^0	95.59^0
150^0	295.49^0	96.27^0
160^0	295.87^0	96.52^0
170^0	294.96^0	96.93^0
180^0	292.32^0	96.83^0

	Minimum		Maximum

The Range of Transmission Angle is the difference between Maximum Transmission Angle and Minimum Transmission Angle. As expressed in the table 1, range of transmission angle µ1 in Phase I is 82.3^0. In the same sense range of transmission angle µ2 is 9.58^0.

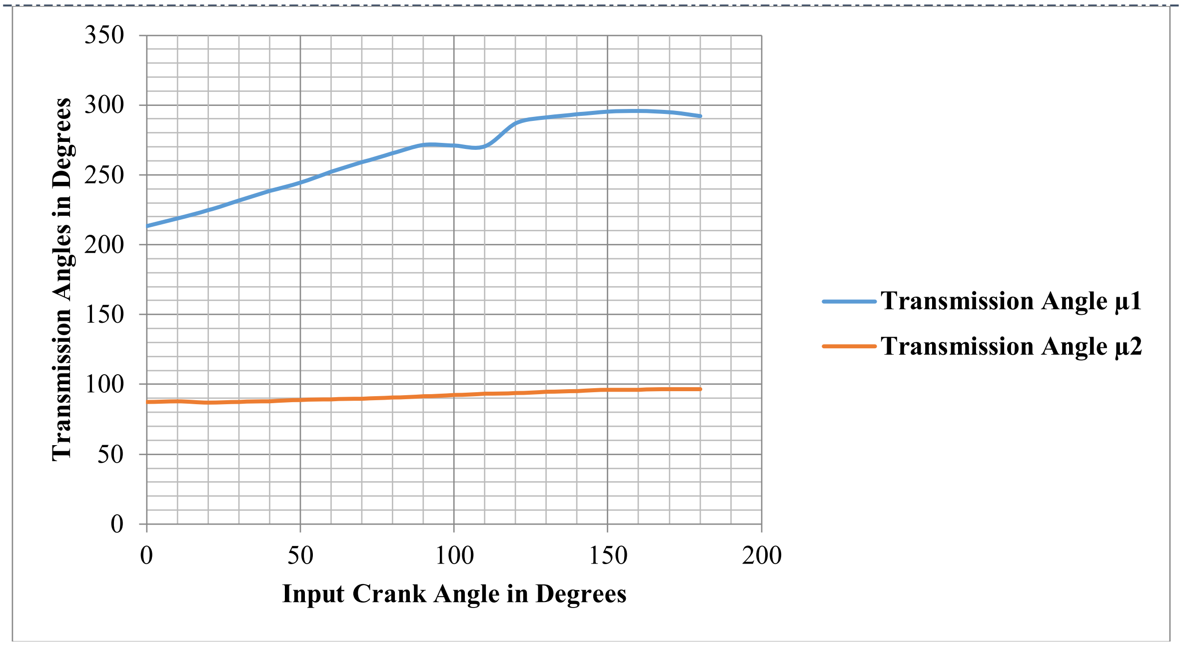

Fig. 2 Plot of Transmission Angles v/s Input Crank Angle in Phase I

Transmission Angles in Eight Link Gear Mechanism with Variable Topology in Phase II

In this phase link O_cC which was temporarily in Phase I operation will be released to move by fixing link O_aA temporarily at the ending position of Phase I. When the input link O_cC is rotated by θ_{12} = -180^0 CW from the starting position, links AB, BC, BD and DO_e get displaced from the starting position and move until they reach the ending position. Due to this action the transmission angles μ_1 and μ_2 also change their values. The table 2 shows the range of transmission angles in Phase II operation of the mechanism. The graph of transmission angles v/s crank angle motion is also plotted.

Table 2 Transmission Angles in Eight Link Gear Mechanism with Variable Topology in Phase II

Input Crank Angle	Transmission Angle µ1	Transmission Angle µ2
0^0	292.44^0	97.16^0
10^0	287.41^0	94.05^0
20^0	282.10^0	91.01^0
30^0	276.26^0	89.17^0
40^0	272.00^0	87.82^0
50^0	267.05^0	87.24^0
60^0	262.71^0	87.22^0
70^0	259.54^0	87.76^0
80^0	256.29^0	88.92^0
90^0	254.20^0	90.61^0
100^0	253.61^0	92.99^0
110^0	252.35^0	97.16^0
120^0	252.98^0	101.19^0
130^0	255.30^0	106.24^0
140^0	257.73^0	111.94^0
150^0	260.92^0	118.17^0
160^0	265.25^0	125.91^0
170^0	269.81^0	134.21^0
180^0	274.21^0	143.55^0

	Minimum		Maximum

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The Range of Transmission Angle is the difference between Maximum Transmission Angle and Minimum Transmission Angle. As expressed in the table 2, range of transmission angle µ1 in Phase II is 40.09^0. In the same sense range of transmission angle µ2 is 56.33^0.

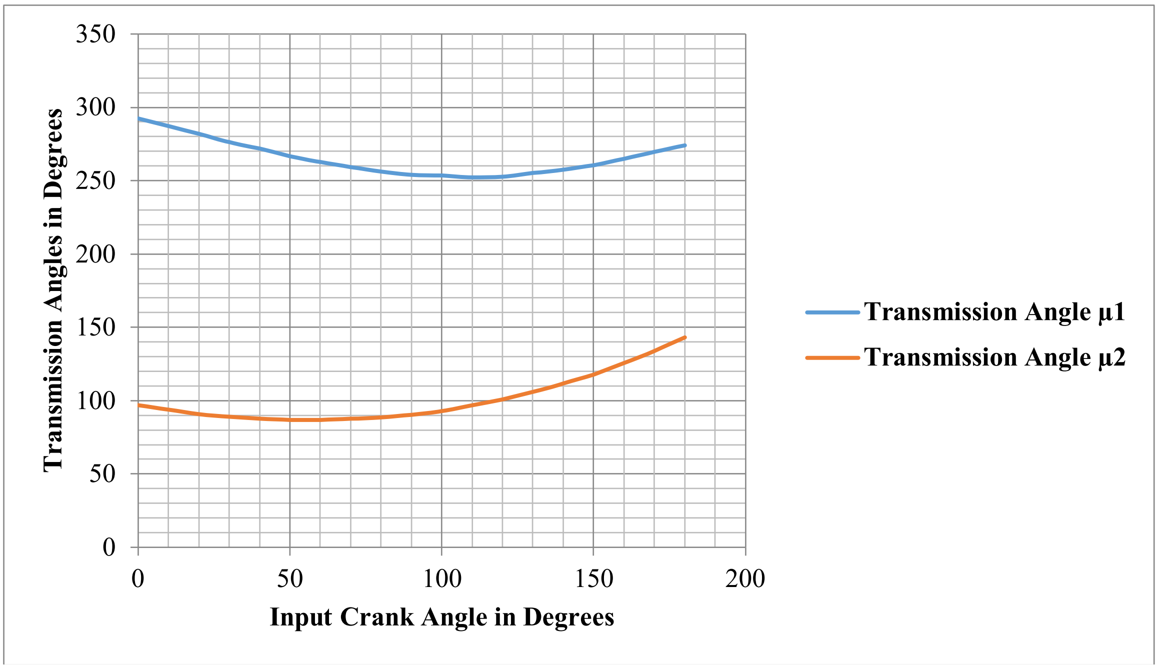

Fig. 3 Plot of Transmission Angles v/s Input Crank Angle in Phase II

3. OUTPUT CHARACTERISTICS OF EIGHT LINK GEAR MECHANISM WITH VARIABLE TOPOLOGY

The fig.1 shows that gear 8 acts as the output link of the mechanism. This output link is common to both the Phases of the mechanism. Output characteristics explain the response of the mechanism to the input motion given provided at the input links. This output can be considered for further assistance in carrying out various tasks. These tasks can be movement of conveyers or movement of trays in case of filtering any particles. Any link which is attached to the output gear also provides the same characteristic feature as the gear behaves. The output characteristic of the mechanism in Phase I and Phase II is explained in detail in further paragraphs. The response curve for input crank angle v/s output angle is also plotted.

Output Characteristics of Eight Link Gear Mechanism with Variable Topology in Phase I

The output characteristic of the eight link gear mechanism in Phase I operation is shown in table 3. For every 10^0 movement of the input crank the movement of output link is taken into consideration. Since the input crank angle movement is limited to 180^0 in this Phase, response of the mechanism is plotted to this limit. The initial position of the input link O_aA is treated Position I of the mechanism which will be considered as 0^0. This position is also called the starting position of the mechanism. When the input link reaches 180^0 this position is treated as Position II of the mechanism which resembles ending position of the mechanism in Phase I. The values presented in table 3 shows that the maximum movement of the output gear is 50.21^0 from its initial position. These values are plotted as shown in fig.4.

Table 3 Output Characteristics of Eight Link Gear Mechanism with Variable Topology in Phase I

Input Crank Angle	Output Angle
0^0	0^0
10^0	1^0
20^0	2^0

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30^0	2.56^0
40^0	4.06^0
50^0	6.09^0
60^0	7.96^0
70^0	10.64^0
80^0	13.33^0
90^0	16.37^0
100^0	20.16^0
110^0	23.67^0
120^0	27.25^0
130^0	31.55^0
140^0	35.66^0
150^0	40.51^0
160^0	43.94^0
170^0	47.65^0
180^0	50.21^0

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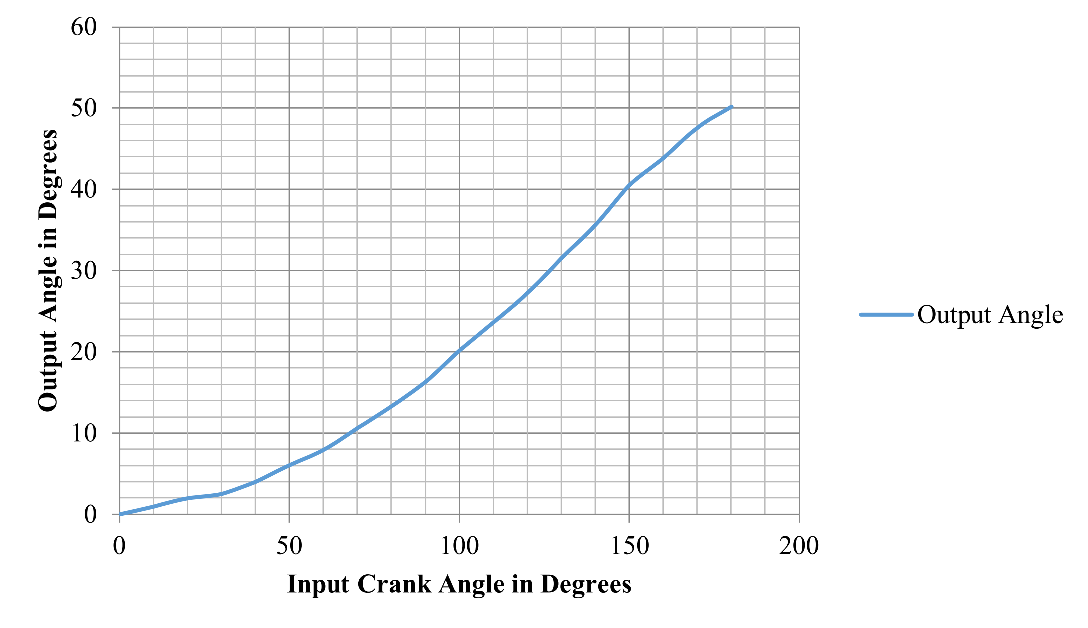

Fig.4 Output Characteristics of Eight Link Gear Mechanism with Variable Topology in Phase I

The output characteristics of eight link gear mechanism with variable topology in Phase I is presented in fig.4. This is the plot of input crank angle v/s output angle of the gear. The response of the mechanism is a parabolic curve.

Output Characteristics of Eight Link Gear Mechanism with Variable Topology in Phase II

The output characteristic of the eight link gear mechanism in Phase II operation is shown in table 4. For every 10^0 movement of the input crank the movement of output link is taken into consideration. Since the input crank angle movement is limited to 180^0 in this Phase also, the response of the mechanism is plotted to this limit. The initial position of the input link O_cC is treated Position II of the mechanism which will be considered as 0^0. This position is also called the starting position of the mechanism in Phase II and ending position in Phase I. When the input link reaches 180^0 this position is treated as Position III of the mechanism which resembles ending position of the mechanism in Phase II. The values presented in table 4 shows characteristic behavior of the mechanism in this Phase.

Table 4 Output Characteristics of Eight Link Gear Mechanism with Variable Topology in Phase II

Input Crank Angle	Output Angle
0^0	0^0
10^0	-1.15^0
20^0	-2.49^0
30^0	-3.29^0
40^0	-3.56^0
50^0	-4.01^0
60^0	-4.05^0
70^0	-4.01^0
80^0	-4.01^0
90^0	-3.99^0
100^0	-3.99^0
110^0	-4^0
120^0	-2.56^0
130^0	-0.72^0
140^0	2.04^0
150^0	4.06^0

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160^0	6.63^0
170^0	10.17^0
180^0	13.85^0

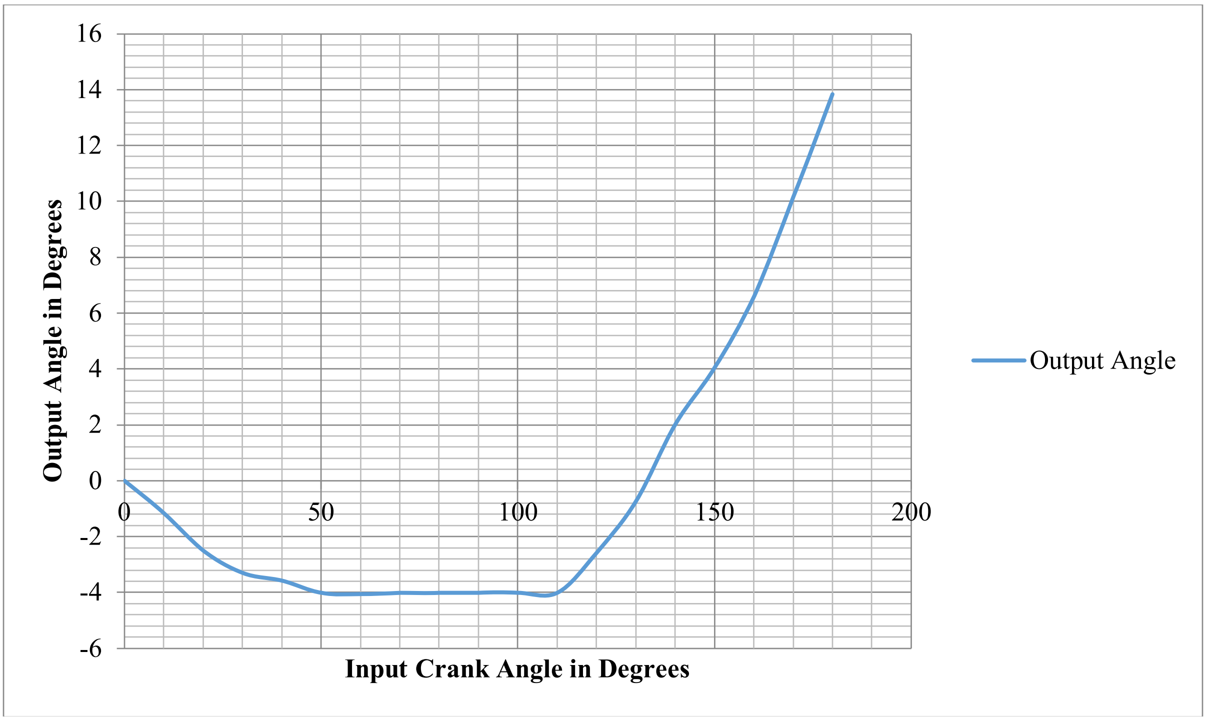

Fig.5 Output Characteristics of Eight Link Gear Mechanism with Variable Topology in Phase II

The Output Characteristics of Eight Link Gear Mechanism with Variable Topology in Phase II is presented in fig.5. This is the plot of input crank angle v/s output angle. The response of the mechanism is a non parabolic curve. The input crank angle varies its movement form the initial position. In response to this action the output link that is gear 8 provides an output which is varying from negative to positive in nature. This is observed because, for every input crank angle movement the output link moves in counterclockwise direction to a particular limit then returns in clockwise direction. Counterclockwise response of the link is observed in every stages of the movement. This behavior changes at the 120^0 movement of the input crank angle. From 120^0 to 180^0 response of the output link varies from counterclockwise to clockwise which is positive in nature.

4. FUTURE PERSPECTIVE OF TRANSMISSION ANGLES AND OUTPUTS IN MECHANISM

The work carried out in the paper illustrates the behavior of transmission angle. This can be considered as one of the design parameter in synthesizing the mechanism. The transmission angle study also provides a pictorial view of the values that are occurring during the functioning of a mechanism.

5. CONCLUSION

An observation study on transmission angle behavior of synthesized variable topology eight link gear mechanism predicts that, occurrence and variation of the values can be visualized easily through the graphical view. The curves obtained help to develop a comparative channel to the existing behavior of transmission angles and outputs of the mechanism. The obtained results can be verified analytically using mathematical formulae suggested by the early contributors in the field of mechanisms.

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