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# Nomographs for synthesis of epicyclic-type automatic transmissions

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**Abstract** This paper presents a MATLAB optimization technique for the determination of the gear ratios of epicyclic-type transmission mechanisms for a given set of velocity ratios. First, all of the feasible clutching sequences are enumerated directly without using complicated techniques. Then, for the transmission mechanism with the associated clutching sequence graph, the overall velocity ratios are derived and expressed in terms of the gear ratios of all the mating gears. Next, following the general trend of increased shift stages and a wider range of velocity ratios, the numbers of teeth of all gears are estimated by MATLAB optimization technique in a single run.

Ravigneaux gear mechanisms are used as design examples. The methodology can be applied to any transmission mechanism depending on its kinematic and geometric constraints. New five- and six-velocity automatic transmissions are enumerated from the Ravigneaux gear mechanism. It is a major breakthrough to design a completely satisfactory six-speed automatic transmission from the Ravigneaux gear mechanism since it has only eight links. The new design makes use of the benefits of the Ravigneaux gear train and overcomes the previous art difficulties. This structural design has realized a six-speed automatic transmission, while having minimal number of clutches, and brakes. It is also low cost due to adoption of the conventional available Ravigneaux gear train.

**Keywords** Automatic transmission · Epicyclic gear mechanism · Nomographs · Optimization · Ravigneaux · Velocity ratios

## 1 Introduction

Most automatic transmission mechanisms employ epicyclic gear trains (EGTs) to achieve a set of desired velocity ratios. Figure 1 shows an EGT employing a seven-link Ravigneaux gear train as an automatic transmission. Table 1 shows the clutching sequence of the transmission shown in Fig. 1, where an X$i$ indicates that the corresponding clutch is activated on the $i$th link for that gear.

This gear train has been developed by nearly all automotive manufacturers as three- or four-velocity automatic transmission [1]. It can be found in KM 175 and 176, Ford AOD, and Borg–Warner [2], to name a few four-velocity automatic transmissions. All of them adopt a seven-link two-DOF Ravigneaux gear mechanism, as shown in Fig. 2(a). Seven-link two-DOF Ravigneaux gear train is also integrated with a simple epicyclic gear train to form ten-link three-DOF epicyclic gear mechanism to enhance the number of speeds [3, 4], providing six forward speeds.

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