

Indian Institute of Technology Delhi
Department of Mechanical Engineering

Minor test-2 (24/03/2023, Friday)

MCL321- Automotive Systems

Time: 11am to 12.10 pm

Max. Marks: 30

Instructions: Please attempt all the questions. Marks of each questions are indicated at associated RHS. Use scale, pencil and other drawing instruments in preparing the sketches/diagrams.

Q.1 (a) What is a Hooke's joint? With a neat sketch, describe the working of a Hooke's joint. Also prove that for a Hooke's joint the following relation holds:

$$\tan(\theta) = \cos(\alpha) \cdot \tan(\phi)$$

where α = angle of inclination of the driven shaft with driving shaft
 ϕ and θ = angles turned by driven and driving shafts at any instant

Moreover, prove that the ratio of the angular velocities of the driven and driving shafts for a Hooke's joint is given by:

$$\omega_2/\omega_1 = [\cos(\alpha)]/[1 - \cos^2\theta \times \sin^2\alpha]$$

(Marks: 2+3+3+4)

(b) Determine the greatest permissible angle between the axes of the two shafts which are connected by a Hooke's joint if the maximum variation in the speed of the driven shaft is $\pm 4\%$ of the mean speed. The driving shaft is rotating at a uniform speed of 600 rpm. Also find the maximum and the minimum speeds of the driven shaft. (Marks: 6)

Q.2 (a) Illustrate the Wilson gearbox diagrammatically. Explain the First gear, Second gear, Third gear, Reverse gear and Top gear actions in this gearbox. (Marks: 6)

(b) Details of a compound epicyclic gear drive have been provided in the following figure. 'I' is the driving or input shaft and 'O' is the driven or output shaft which carries two arms 'A' and 'B' rigidly fixed to it. The arms carry planet wheels which mesh with annular wheels 'P' and 'B' rigidly fixed to it. The arms carry planet wheels which mesh with annular wheels 'P' and 'Q' and the sun wheels 'X' and 'Y'. The sun wheel 'X' is a part of 'Q'. Wheels 'Y' and 'Z' are fixed to the shaft 'I'. 'Z' engages with a planet wheel carried on 'Q' and this planet wheel engages the fixed annular wheel 'R'. The numbers of teeth on the wheels are: P = 114, Q = 120, R = 120, X = 36, Y = 24 and Z = 30.

The driving shaft 'I' makes 1500 rpm clockwise looking from our right and the input at 'I' is 7.5 kW. Find the speed and direction of rotation of the driven shaft 'O' and the wheel 'P'. (Marks: 6)


