**ME 352A**

**EPICYCLIC GEAR TRAIN EXPERIMENT**

**GROUP – A4**

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**INTRODUCTION:**

Any combination of gear wheels by means of which motion is transmitted from one shaft to another shaft is called a gear train. In case of epicyclic gear trains, the axes of the shafts on which the gears are mounted may move relative to a fixed axis. The [gear ratio](https://en.wikipedia.org/wiki/Gear_ratio) of an epicyclic gearing system is somewhat non-intuitive, particularly because there are several ways in which an input rotation can be converted into an output rotation. The three basic components of the epicyclic gear are:

* *Sun*: The central gear
* *Carrier*: Holds one or more peripheral *Planet* gears, all of the same size, meshed with the sun gear
* *Ring or Annulus*: An outer ring with inward-facing teeth that mesh with the planet gear or gears

In many epicyclic gearing systems, one of these three basic components is held stationary; one of the two remaining components is an *input*, providing power to the system, while the last component is an *output*, receiving power from the system. The ratio of input rotation to output rotation is dependent upon the number of teeth in each gear, and upon which component is held stationary.

In one arrangement, the planetary carrier (green) is held stationary, and the sun gear (yellow) is used as input. In this case, the planetary gears simply rotate about their own axes (i.e., spin) at a rate determined by the number of teeth in each gear. If the sun gear has *Ns*teeth, and each planet gear has *Np* teeth, then the ratio is equal to −*Ns*/*Np*. For instance, if the sun gear has 24 teeth, and each planet has 16 teeth, then the ratio is −24/16, or −3/2; this means that one [clockwise](https://en.wikipedia.org/wiki/Clockwise_and_counterclockwise) turn of the sun gear produces 1.5 *counterclockwise* turns of each of the planet gear(s) about its axis.

**THEORY:**

Torque analysis in epicyclic gear train: If the parts of an epicyclic gear train are all moving at

uniform speeds, so that no angular accelerations are involved, the algebraic sum of all the

external torques applied to the train must be zero, or,

Σ (T) = 0

There are three external torques for every train. These are,

Ti : Input torque on the driving member

To : Output torque or load torque on the driven member

Th : Holding torque or braking torque on the fixed member

Hence, if there is no acceleration,

Ti + To + Th = 0

**EXPERIMENT:**

To study and verify the torque relationship,

**Ti + To + Th = 0**

Where,

**Ti** = Input torque on the driving member

**To** = Output torque or load torque on the driven member

**Th** = Holding torque or braking torque on the fixed member

Input Torque, Ti

Here,

Motor torque × Motor angular velocity = Output torque × Output shaft angular velocity Motor torque = Input torque

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Ti ×** | **m = To × os** | | | |  |  |
| **or,** | **Ti ×** |  | **× Nm = To ×** | | |  | **× No** |
|  |  |
| **or,** | **Ti = To ×** | | |  |  |  | **............ (A)** |
|  |  |

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Where,

Nm = RPM of motor

No = RPM of output shaft

Output Torque, To

Here,

**To = (S2 - S3) × RP ............ (B)**

Where,

S2 = Load in spring balance 2 in Newtons

S3 = Load in spring balance 3 in Newtons

RP = Effective radius of pulley in Meters (0.125 m)

Holding Torque, Th

Here,

**Th = S1 × RHD** **............ (C)**

Where,

S1 = Load in sring balance 1 in Newtons

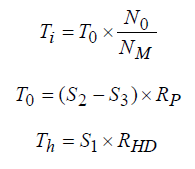
RHD = Effective radius of holding drum in Meters (0.185 m)

Hence, using equations A, B and C all the three torques can be determined

**Observation Table:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S. No | RPM  No | RPM  NM | Load S1  (N) | Load S2  (N) | Load S3  (N) | Input  Torque(Ti) | Output Torque(To) | Holding  Torque(Th) | Ti + To + Th |
| 1 | 200 | 1090 | 0.5 | 0.2 | 1.25 | 0.018 | -0.1 | 0.0925 | 0.0105 |
| 2 | 180 | 986 | 4.75 | 2.5 | 11.25 | 0.198 | -1.09 | 0.88 | -0.012 |
| 3 | 160 | 870.5 | 9.25 | 5.8 | 23.75 | 0.409 | -2.23 | 1.71 | -0.10 |
| 4 | 140 | 761 | 17.0 | 8.85 | 39.375 | 0.7 | -3.81 | 3.14 | 0.03 |
| 5 | 120 | 645.5 | 27.0 | 15.9 | 63.75 | 1.09 | -5.9 | 4.995 | 0.18 |

**FORMULAE:**



***R****p* = Effective radius of pulley (0.125 m)

***R****HD* = Effective radius of holding drum (0.185 m)

**SAMPLE CALCULATION:**

For S.No. – 3

To = (5.8 – 23.75)\*0.125 = -2.23 N.m

Th = 9.25\*0.185 = 1.711 N.m

Ti = 2.23\*(160/870.5) = 0.409 N.m

Ti + To + Th = -0.10 N.m (approx. small)