Freshmen Summer Internship Program 2013
Assignment 3

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Electrical Subsystem

Section A: Drivetrain (Basic)

1)

No	Name	Functions and Description	Applications
(i)	Ball Bearing	Type of a rolling element which uses balls to maintain separation between at least two bearing races. Transmits loads between one stationary and one rotating assembly through balls. Reduces rotational friction and supports radial and axial loads.	Contact between the wheels and axle.
(ii)	Angular Contact Bearing	The raceways here are displaced with respect to each other in the direction of the bearing axis. This type of assembly accommodates radial and axial loads simultaneously.	Contact between the wheels and axle.
(iii)	Cylindrical Roller Bearing	Rollers are in linear contact for the races. They have high radial load capacity and are suitable for high speeds.	Paper making machinery, Wind turbines, Gear boxes, Electric motors, Motorcycles.
(iv)	Tapered Roller Bearing	Inner and outer raceways are sections of a cone, and rollers are also made with a taper. It gives larger contact patch, and permits larger loads to be carried with spherical bearings.	Car and vehicle wheel bearings. Construction and mining equipment. Axle systems, gear boxes, engine motors.
(v)	Needle Roller Bearing	Uses small cylindrical rollers. Used to reduce friction of a rotating surface. Have a large surface area that is in contact with the outer surfaces of the bearing and are much more compact.	Rocket arm pivots, pumps, compressors. Driveshafts of rear wheel drive vehicles.

2) The gears used in the gearboxes of the EVo2 are helical gears.

No	Gear Type	Advantages	Disadvantages	Applications
(i)	Spur Gear	Easiest to design and manufacture. Most efficient. Cheap to purchase and	More noise. Slow speeds. Cannot transfer power between non-parallel	Gearboxes, in case of parallel shafts. Load transfer.

		maintain (teeth are straight rather than angular)	shafts. Low load capacity.	Changing rpm.
(ii)	Helical Gears	Silent operation. Can transfer power between nonparallel shafts. Can handle more load.	Less efficiency. More cost. Not easy to manufacture.	Car gearbox. Machine tools.
(iii)	Bevel Gears	Makes it possible to change operating angle. Differing number of teeth on each wheel allows mechanical advantage to be changed.	One wheel of such a gear is designed to work only with its complementary, and must be precisely mounted.	Differential drives. Hand drills. Rotorcraft.

3)

Advantages	**Disadvantages**
High power density. Large reductions possible in small volume. Multiple kinematic combinations. Pure torsional reactions. Awesome power transmission efficiencies. Very compact. Torque capabilities greatly increased due to load distribution. High rotational stiffness. Greater stability.	High bearing loads. Constant lubrication requirements. Inaccessibility. Design complexity.

Derivation:

ω_p = Angular Velocity of the Planet Gears, r_p = Radius of the Planet Gears.

ω_s = Angular Velocity of the Sun Gear, r_s = Radius of the Sun Gear.

ω_a = Angular Velocity of the Annulus, R = Radius of the Annulus, with $R = r_s + r_p$.

1) **In case Sun Gear in kept fixed:** We equalize the velocities of the gears which touch at the contact points. This gives:

   $\omega_a R = 2\omega_p r_p$ giving a gear ratio of $\frac{2r_p}{R}$ or $\frac{R}{2r_p}$

2) **In case Planet Gears are kept fixed:** Equalizing the velocities we get:

   $\omega_s r_s = \omega_p r_p = \omega_a R$ giving a gear ratio of $\frac{r_s}{R}$ or $\frac{R}{r_s}$

3) **In case Annulus is kept fixed:** Equalizing the velocities we get:

   $\frac{2r_s}{r_p}$ or $\frac{r_p}{2r_s}$