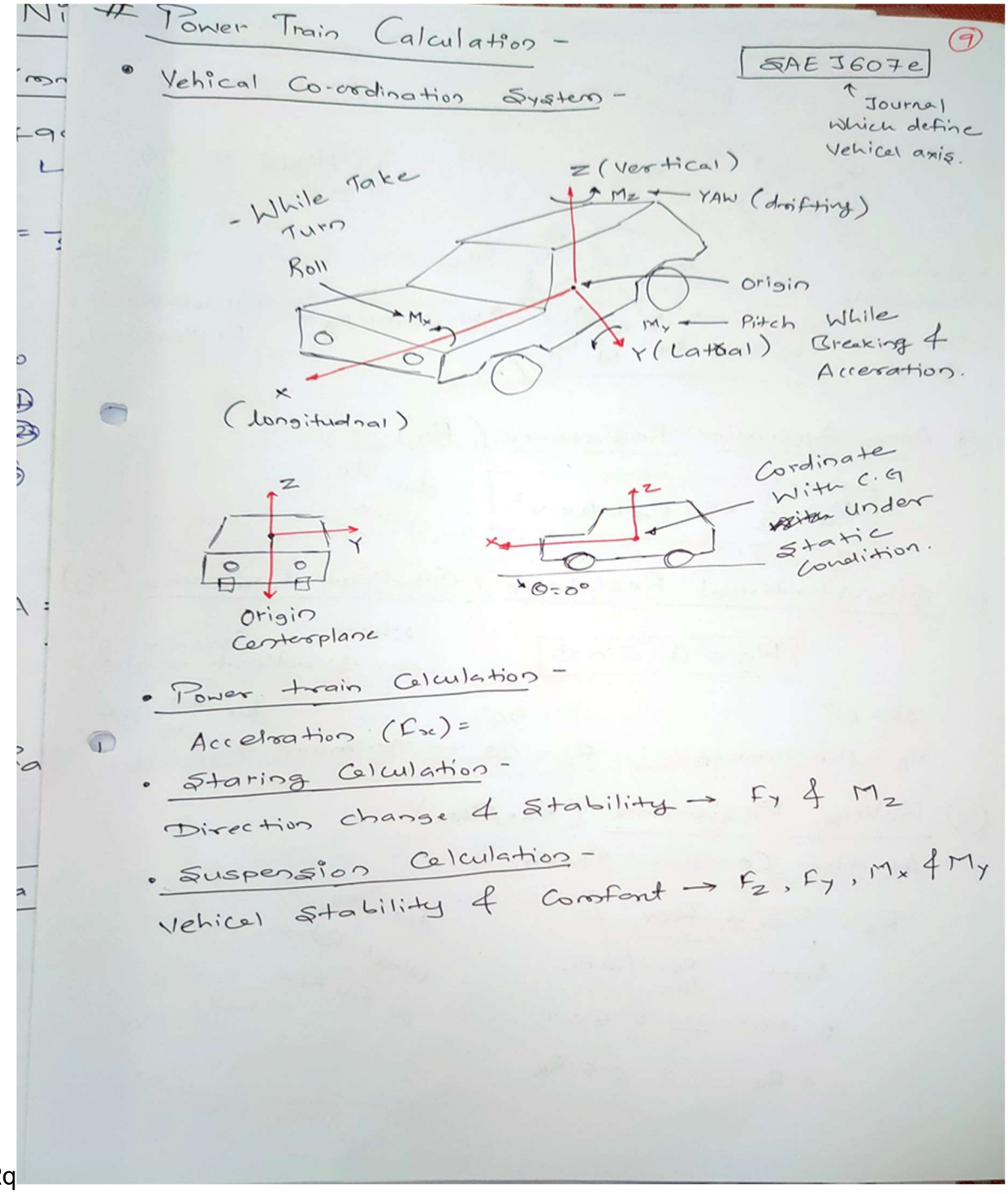
Assignment 2

Unit 2: Electric Vehicle Powertrain Selection

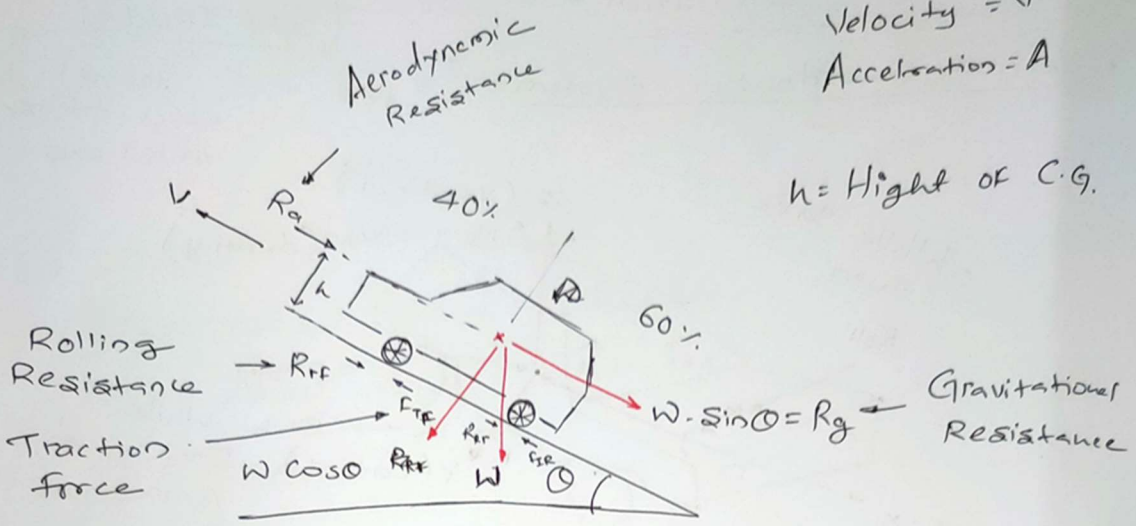
Q1. Drive the Equation of motion and maximum tractive effort for a car inclined at angle θ. Also give the expression of maximum gradeability for a 4 wheel drive.



Q2q

Velocity = V
Acceleration = A

h = Hight of C.G.



① Aero dynamic Resistance (R_a)

$$R_a = \frac{1}{2} \times \rho \times C_d \times A \times V^2$$

due to air

② Gravitational Resistance / Gradient Resistance (R_g)

$$R_g = W \sin\theta$$

Where,
θ = gradient angle

$\theta = 0°$

$R_g = 0$ ← minimum

$\theta = 90°$

$R_g = W$ ← Maximum

due to gravity act

③ Roling Resistance (R_{RF}/R_{RR})

At the Contact Patch.

$$R_R = \underbrace{R_{RF}}_{\text{front}} + \underbrace{R_{RR}}_{\text{Rear/Back}}$$

due to Wheel Roling at friction.

F 40% — R 60%.

0.4 R_R — 0.6 R_R

④ Traction force (F_T) :

$$F_T = F_{TF} + F_{TR}$$

40% 60%

$0.4 F_T$ $0.6 F_T$

We have Traction force in favour OF the motion.

Front Wheel drive = $F_T = F_{TF}$

Rear Wheel drive = $F_T = F_{TR}$

* Summary -

$$F_T - (R_a + R_R + R_g) = m \times a$$ ← Acceleration.

↑ mass

$$F_T = (ma) + (R_a + R_R + R_g)$$ ← Resistance

↑ Acceleration resistance.

Where,

ma = mass × Acceleration.

Aero dynamic Calculation -

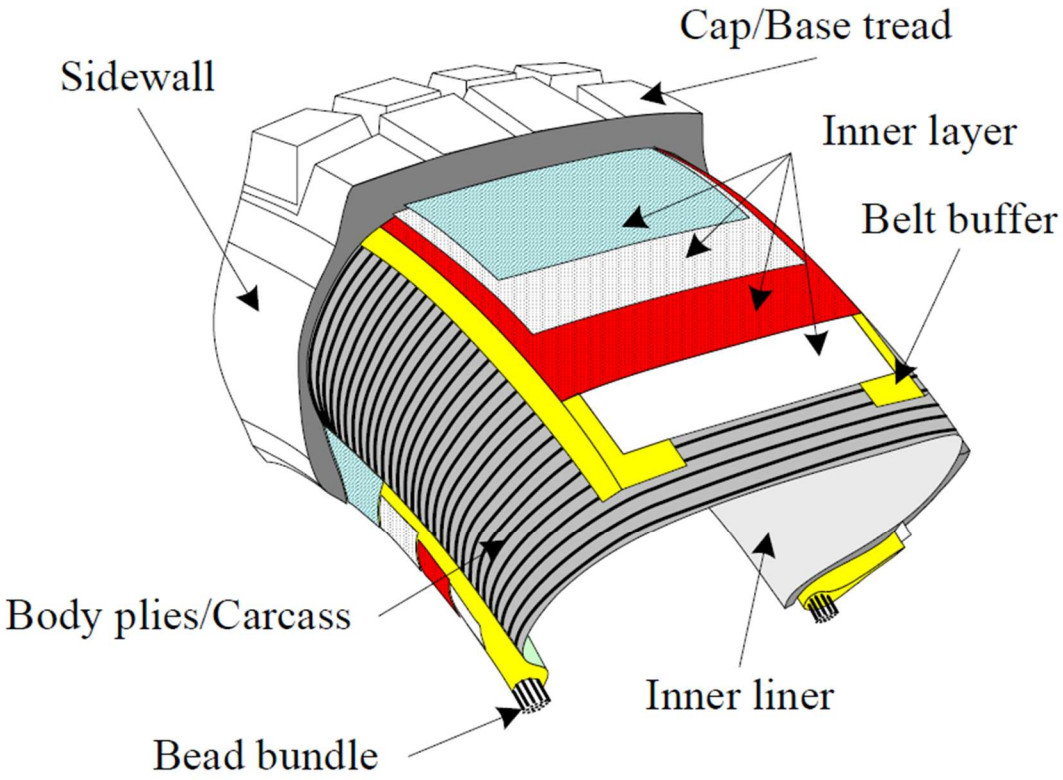
$$R_a = \frac{1}{2} \times \rho \times C_d \times A \times V^2$$

ρ : Air density $1.225\ kg/m^3$ @ 25°C

A : Projected Area

V : Relative Velocity

Q3. What are the different parts of tires? Differentiate between types of tires on the basis of their construction.



A tire is an advanced engineering product made of rubber and a series of synthetic materials cooked together. Fiber, textile, and steel cords are some of the components that go into the tire's inner liner, body plies, bead bundle, belts, sidewalls, and tread. Bead or bead bundle is a loop of high strength steel cable coated with rubber. It gives the tire the strength it needs to stay seated on the wheel rim and to transfer the tire forces to the rim.

Inner layers are made up of different fabrics, called plies. The most common ply fabric is polyester cord. The top layers are also called cap plies. Cap plies are polyesteric fabric that help hold everything in place.Cap plies are not found on all tires; they are mostly used on tires with higher speed ratings to help all the components stay in place at high speeds. An inner liner is a specially compounded rubber that forms the inside of a tubeless tire. It inhibits loss of air pressure.

Tire and Rim Fundamentals

Belts or belt buffers are one or more rubber-coated layers of steel, polyester, nylon, Kevlar or other materials running circumferentially around the tire under the tread. They are designed to reinforce body plies to hold the tread flat on the road and make the best contact with the road. Belts reduce squirm to improve tread wear and resist damage from impacts and penetration.

The carcass or body plies are the main part in supporting the tension forces generated by tire air pressure. The carcass is made of rubber-coated steel or other high strength cords tied to bead bundles. The cords in a radial tire. The plies are coated with rubber to help them bond with the other components and to seal in the air.

A tire's strength is often described by the number of carcass plies. Most car tires have two carcass plies. By comparison, large commercial jetliners often have tires with 30 or more carcass plies. The sidewall provides lateral stability for the tire, protects the body plies, and helps to keep the air from escaping from the tire. It may contain additional components to help increase the lateral stability. The tread is the portion of the tire that comes in contact with the road. Tread designs vary widely depending on the specific purpose of the tire. The tread is made from a mixture of different kinds of natural and synthetic rubbers. The outer perimeter of a tire is also called the crown. The tread groove is the space or area between two tread rows or blocks. The tread groove gives the tire traction and is especially useful during rain
or snow.