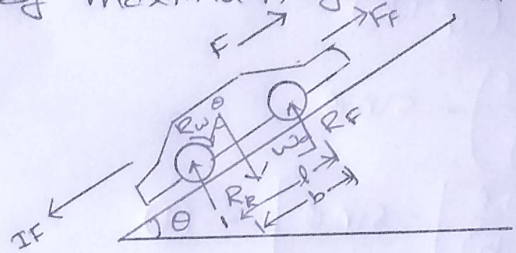
1) Derive the equation of motion and maximum tractive effort for a car inclined at angle θ. Also give the expression of maximum gradeability for a 4 wheel drive.



W = weight of the car

C_G = centre of gravity

b = wheel base

F = max^m forward acceleration

F_F = max^m traction effort

R_F = Reaction Front wheel

R_R and R_F = Total normal reaction at front and rare wheel

h = height from C_G to road

IF = Inertia force = $mf - w\sin\theta$

$= mf - mg\sin\theta$

$= \frac{w}{g} \cdot f - w\sin\theta$ — ①

$\Sigma V = 0$ — ②

$\Sigma H = 0$ — ③

Using ②

$w\cos\theta = R_F + R_R$ — ④

Using ③

$F_F = \frac{w}{g} \cdot f + w.\sin\theta$

$\mu R_F = \frac{w}{g} \cdot f + w\sin\theta$

$R_f = \frac{w}{g} f + \frac{w}{\mu}\sin\theta$ — ⑤ $\frac{w}{\mu}\left(\frac{f}{g} + \sin\theta\right)$

Taking moment about Y

$R_F \times b + \left(\frac{w}{g} \cdot f + w\sin\theta\right) h = w\cos\theta \times l$

$\left(\frac{w}{g}\frac{\theta}{\mu} + \frac{w}{\mu}\sin\theta\right) b + \left(\frac{w}{g} f + w\sin\theta\right) \times h = w\cos\theta \times l$

$$\left(\frac{f}{gM}+\frac{\sin\theta}{\mu}\right)b+\left(\frac{f}{g}+\sin\theta\right)h=\cos\theta l$$

$$\frac{b}{\mu}\left(\frac{f}{g}+\sin\theta\right)+\left(\frac{f}{g}+\sin\theta\right)h=\cos\theta l$$

$$\left(\frac{f}{g}+\sin\theta\right)\left(\frac{b}{\mu}+h\right)=\cos\theta l$$

$$\left(\frac{f}{g}+\sin\theta\right)=\frac{\cos\theta l}{\left(\frac{b}{\mu}+h\right)} \quad -(8)$$

$$\frac{f}{g}=\left(\frac{\cos\theta l}{\left(\frac{b}{\mu}+h\right)}\right)-\sin\theta$$

$$F=g\left[\left[\frac{\cos\theta l}{\frac{b}{\mu}+h}\right]-\sin\theta\right] \quad -(9)$$

$$R_F=\frac{w}{\mu}\times\frac{\cos\theta l}{\left(\frac{b}{\mu}+h\right)} \quad -(10)$$

$$=\frac{w\cos\theta l}{b+\mu h}$$

$$R_R=w\cos\theta-R_F$$

$$=w\cos\theta-\frac{w}{\mu}\frac{\cos\theta l}{\left(\frac{b}{\mu}+h\right)}$$

$$=w\cos\theta\left[1-\frac{l}{(b+\mu h)}\right]$$

$$=w\cos\theta\left[\frac{b+\mu h-l}{b+\mu h}\right)$$

$$F_F=\mu R_F=\mu\times\left(\frac{w\cos\theta l}{b+\mu h}\right)$$

Four wheel drive

$$F=R_F+F_F=\mu R_R+\mu R_F$$

$$\Sigma V=0$$

$$w=R_F+R_R$$

$$\Sigma H=0$$

$$(w/g)F=\mu R_R+\mu R_F$$

$$=\mu(R_R+R_F)=\mu w$$

$$(F/g)=\mu$$

$$\Sigma V=0$$

$$w=R_R+R_F$$

$$\Sigma H=0$$

$(W/g)F = \mu R_R + \mu R_F$

Assuming slip to occured front wheels

$R_F < R_R$ then,

$\Sigma MR = 0$, $2MR_F = (W/g)F$

$R_F b + (W/g) f_n = Wl$

2. consider a car with the following specifications that is parked on a level road. And the load on the front and rear axles. $m = 1765$ kg, $l = 2.84$ m $a_1 = 1.22$ m $a_2 = 1.62$ m.

Ans.

$m = 1765$ kg

$l = 2.84$ m

$a_1 = 1.22$ m

$a_2 = 1.62$ m

load on front axles = $F_{AF} = mg\left(\frac{a_2}{l}\right)$

load on rear axles = $F_{AR} = mg\left(\frac{a_1}{l}\right)$

$F_{AR} = mg\left(\frac{a_1}{l}\right)$

$= 1765 \times 9.8 \left(\frac{1.22}{2.84}\right)$

$= 17297 \times 0.429$

$= 7430.40$N

load on Rear axles = 7430.40N

$F_{AF} = mg\left(\frac{a_2}{l}\right)$

$= 1765 \times 9.8 \left(\frac{1.62}{2.84}\right)$

$= 17297 \times 0.570$

$= 9866.59$N

Load on front axels = 9866.59N

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

1. Beads:

We'll start from the inside out tire beads hold the tire to the rim or the outer edge of the wheel. They're made of copper, brass or bronze plated high tensile steel wires wound into a rubber band. Tire beads prevent the tire

sliding out of place when the wheel rolls

2. Bead filler

Bead filler is a rubber compound inside the tire's beads. It provides stability to lower sidewall and bead area. The density and stiffness of a tire's bead filler help to determine a tire's performance characteristics

3. Radial cord Body.

The cord body gives the tire strength and transmits cornering forces from the tread to the wheel. Rubber coated fabric cord, called body plies, make up the cord body. Body plies can be made of polyster, rayon or nylon. Polyster is most commonly used.

4. Inner Liner

The inner liner is rubber compound bounded to the inside of the cord body that retains air under pressure It has no cord reinforcement and it functions like an inner tube. That modern car tires no longer have inner tubes inside them. A tire's beads, bead filler and inner liner work together to hold air within the tire wall.

5. Belt plies

Belt plies are two or more strong layers of cord just under the tread area of the tire. The primary function of belt plies is to provide strength and stability ~~and~~ to the tire tread. They play a role that is impacting ~~tire~~ tire milage, impact resistance and traction. Steel is the most common cord material used in belt plies.

6. Side wall

The ~~area~~ area of a tire from the bead to the tread, the side of the tire is called the side wall, It forms a protective covering for the cord body.

7. Tread

The tread is the portion of the tire that comes in contact with the road surface. The tread's compound and its design have to balance wear traction, handling, fuel economy, resistance and other characteristics of the tire.

Types of tyres on the basis of their construction

Bias tires	Radial Tires
Nylon Belts	Steel belts
Standard Duty	Severe/ extreme duty
Less expensive	More expensive.
Low Life expentancy	Long life expectancy