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By-Padmesh Sir

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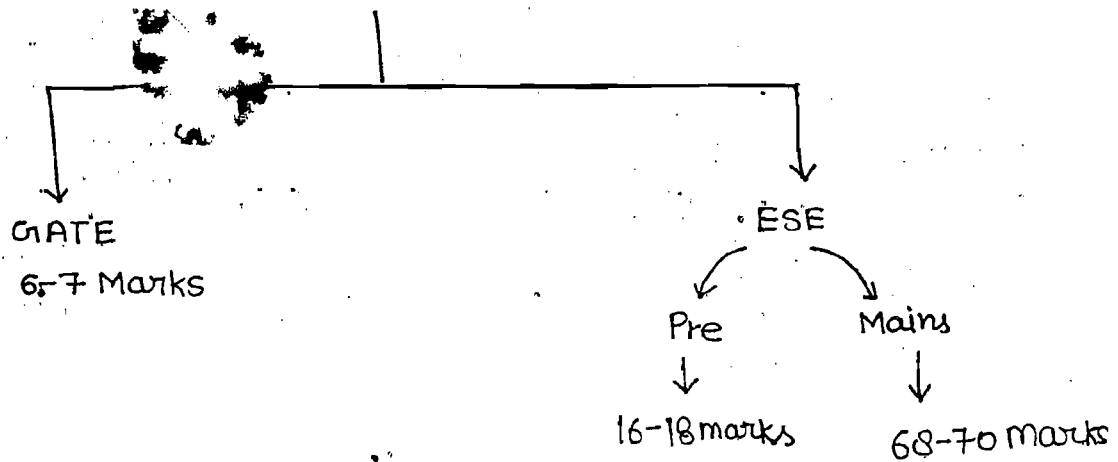
MACHINE DESIGN (MD)

(or)

MACHINE ELEMENT DESIGN (MED)

(or)

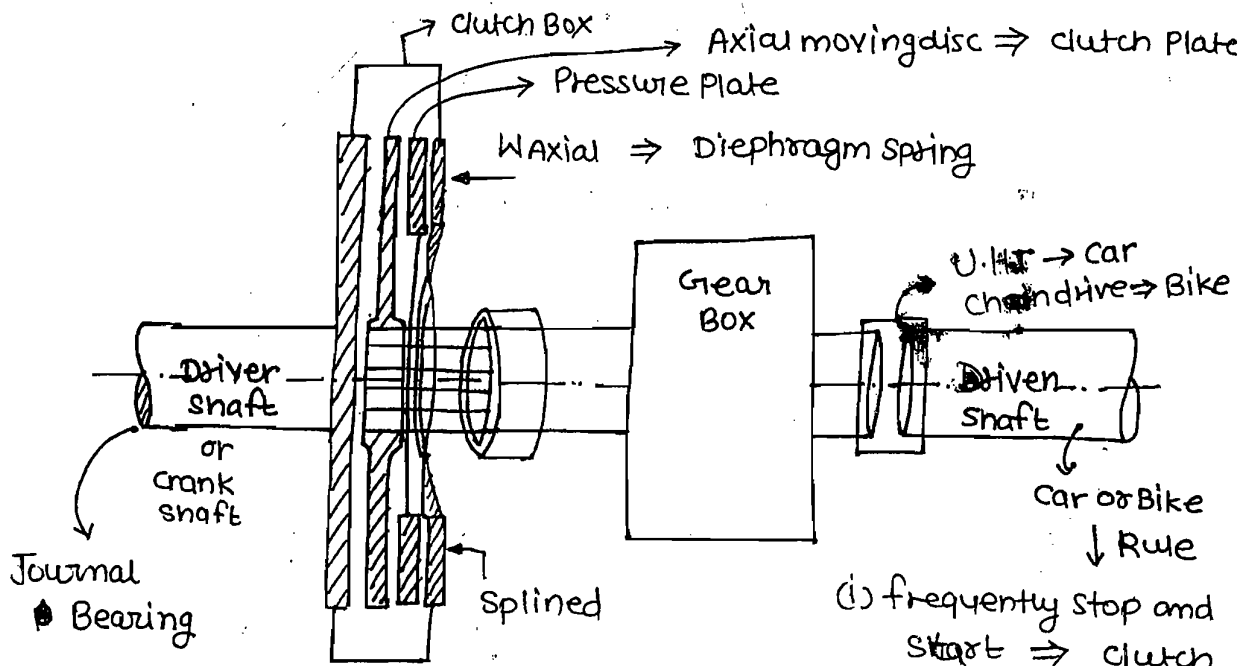
DESIGN OF MACHINE ELEMENT (DME)



- (i) clutches
- (ii) Brakes
- (iii) Gear \Rightarrow (spur Gear)
- (iv) Riveted Joint
- (v) Bolted Joint
- (vi) Welded Joint
- (vii) Bearing
- (viii) Fatigue design of shaft
- (ix) Spring
- (x) Design of flywheel [only ESE]

clutch :->

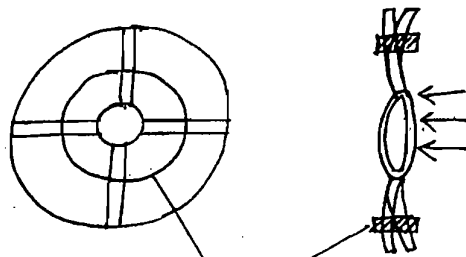
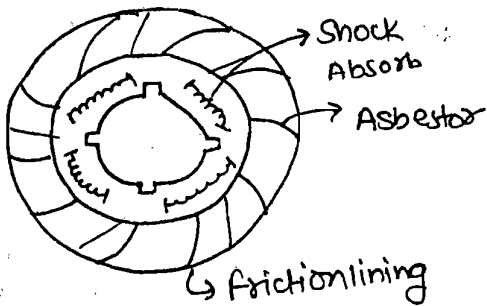
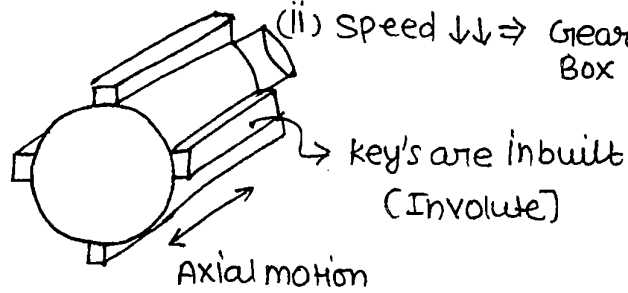
It is defined as a machine element which is use to engage and disengage driver and the driven shaft at the wheel without stopping the prime mover.



- (i) Run continuously
- (ii) speed ↑↑

(i) frequently stop and start => clutch

(ii) speed ↓↓ => Gear Box



Q Why clutches are prefer at High speed side or engine side ?

Ans -> $Power = T_f \times \omega$ ↑↑↑
High speed



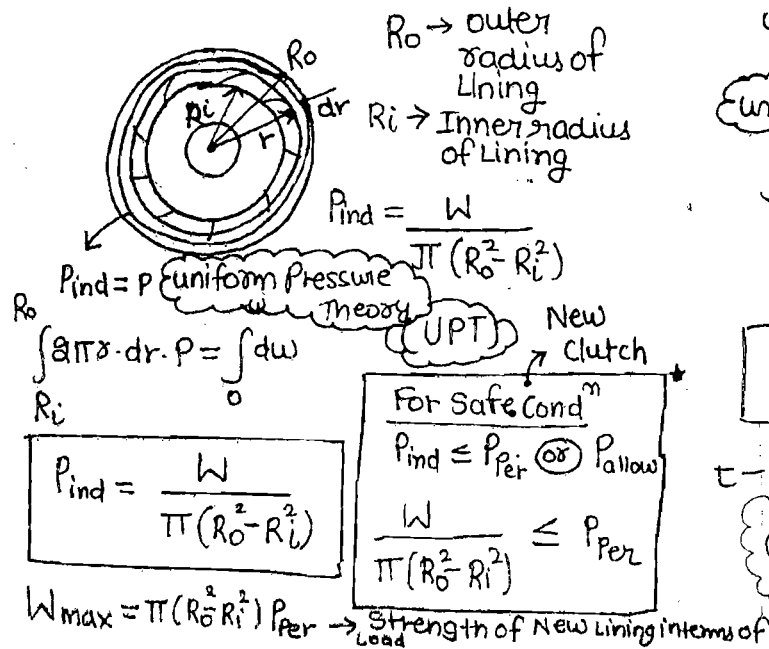
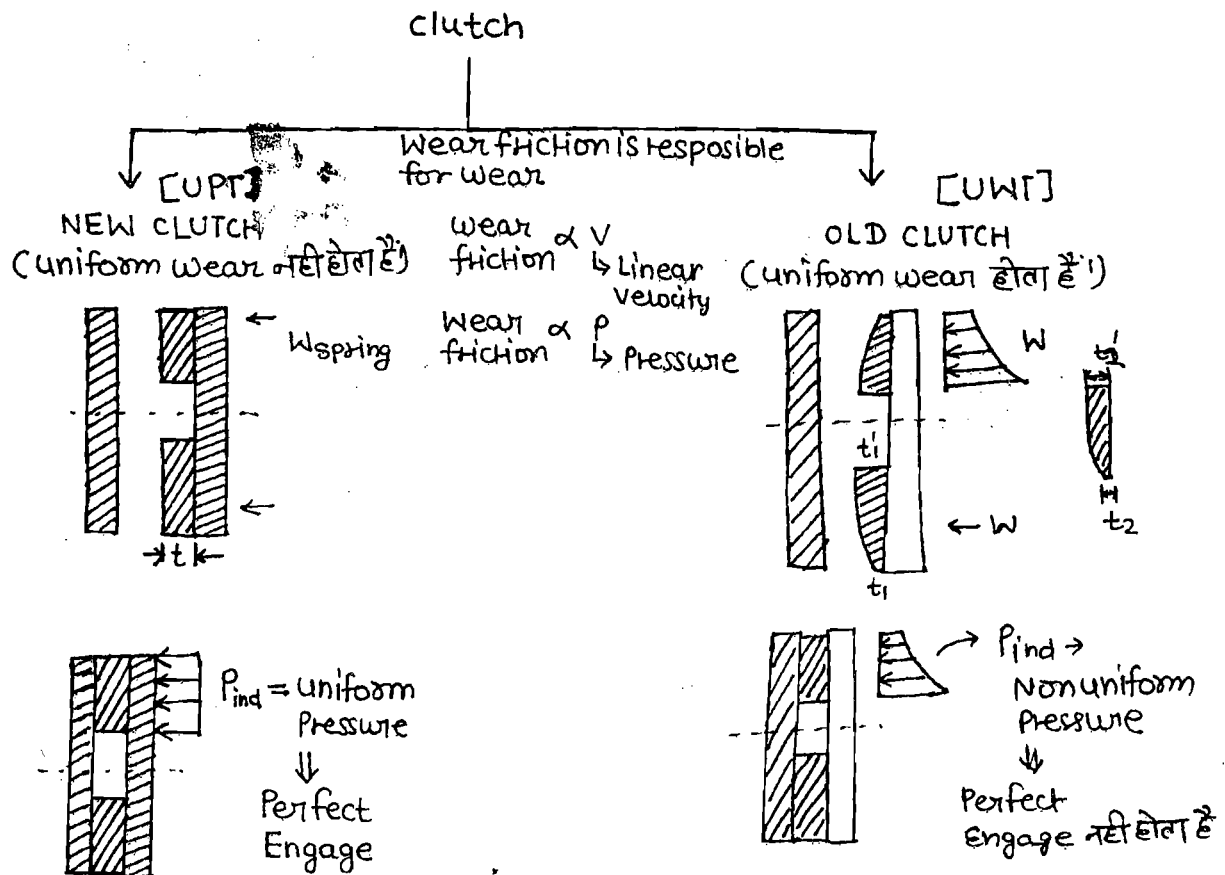
$T_f \rightarrow$ Required torque Less

Clutch design simple

\rightarrow To minimize wear and losses clutch @ Low speed side

Power = $T_f \cdot \omega \downarrow \downarrow$

(Torque Required will be more)



Pressure $\cdot r = \text{constant} \Rightarrow P \cdot r = c$
wear friction = constant

\downarrow

uniform wear Theory (UWT)

$\int_{R_i}^{R_o} 2\pi r \cdot p \cdot dr = \int_0^W dw$

$2\pi \int_{R_i}^{R_o} \frac{c}{r} \cdot r \cdot dr = W \Rightarrow c = \frac{W}{2\pi(R_o - R_i)}$

$P_{ind} = \frac{W}{2\pi r(R_o - R_i)}$

$t - t_1 > t - t_1', t_1 - t_2 = t_2 - t_2'$

For safe condⁿ
 $(P_{ind})_{max} \leq P_{per}$
 $\uparrow P_{ind} = \frac{W}{2\pi r(R_o - R_i)}$

$(P_{ind})_{max} = \frac{W}{2\pi R_i(R_o - R_i)} \leq P_{per}$
 $\frac{W}{2\pi R_i(R_o - R_i)} \leq P_{per}$
 $W_{max} = 2\pi R_i(R_o - R_i) P_{per}$
Strength of old lining

New clutch
Frictional torque

$$F_f = \mu R_N = \mu dW = 2\pi r dr \cdot p \cdot \mu$$

$$\int dT_f = \int_{R_i}^{R_o} 2\pi \mu p r^2 dr = 2\pi \mu p \int_{R_i}^{R_o} r^2 dr$$

$$T_{f_{max}} = \frac{2}{3} \mu \pi p_{per} (R_o^3 - R_i^3)$$

NEW CLUTCH \Rightarrow UPT
 \Downarrow
 $P_{ind} = c$

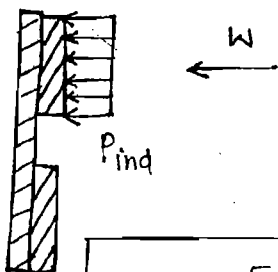
$$P_{ind} = \frac{W}{\pi (R_o^2 - R_i^2)}$$

safe condition

$$P_{ind} \leq P_{per}$$

$$W_{max} = \pi (R_o^2 - R_i^2) P_{per}$$

$$T_{f_{max}} = \frac{2}{3} \mu \pi P_{per} (R_o^3 - R_i^3)$$



$$R_{eff} = \frac{2}{3} \left[\frac{R_o^3 - R_i^3}{R_o^2 - R_i^2} \right]$$

old clutch

$$\int dT_f = \int_{R_i}^{R_o} 2\pi \mu \cdot p \cdot r^2 dr$$

$$T_f = 2\pi \mu \int_{R_i}^{R_o} \frac{c}{r} \cdot r^2 dr$$

$$T_f = \pi \mu c (R_o^2 - R_i^2)$$

$$c = \frac{W}{2\pi (R_o - R_i)}$$

$$T_{f_{max}} = \mu W_{max} \left(\frac{R_o + R_i}{2} \right)$$

$$T_{f_{max}} = \mu \pi P_{per} R_i (R_o^2 - R_i^2)$$

OLD CLUTCH \Rightarrow UWT
 \Downarrow
 $P \cdot r = c$

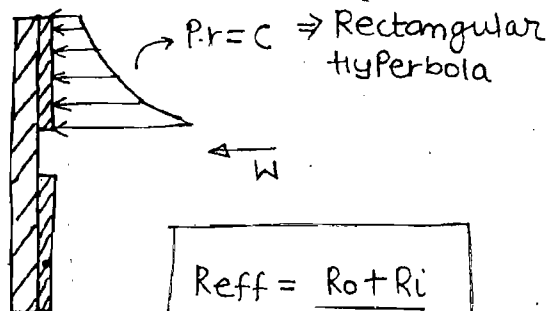
$$P_{ind} = \frac{W}{2\pi r (R_o - R_i)}$$

safe condition

$$(P_{ind})_{max} \leq P_{per}$$

$$W_{max} = 2\pi R_i (R_o - R_i) P_{per}$$

$$T_{f_{max}} = \mu \pi P_{per} (R_o^2 - R_i^2)$$



$$R_{eff} = \frac{R_o + R_i}{2}$$