**7. CLUTCH**

Clutch is a machine element [intermediate] which is used to transmission power from driving shaft [power source] to driven shaft [gear box] at the will of operator.

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| **TYPES OF CLUTCHES** | | | | | |
| **Friction Clutch** | | | | **Positive Clutch** | |
| Single Plate | Multi Plate | Cone Clutch | Centrifugal Clutch | Square jaw Clutch | Spiral jaw Clutch |

**Assumptions:** Pressure over the friction lining is to be constant (p).

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| --- | --- |
| dN = p 2πr dr, df = μ dN, dT = r df | W = axial load required for engagement,  N = Normal reaction between the contacting surface,  ri = inner radius of friction lining,  ro = outer radius of friction lining,  T = Total frictional torque = Total torque transmitted. |

|  |  |
| --- | --- |
| **UNIFORM PRESSURE THEORY** | **UNIFORM WEAR THEORY** (Considered for design) |
| **Condition:** Pressure in radial direction (p) | **Condition:** Wear = Constant |
| p = Constant | Here, Wear ∝ p, V, V = velocity = r ω  Hence, pr = constant (rectangular hyperbola) |
| N = Uniform pressure \* Area of friction lining  = p π () | Where, |
| T = μN rp= μW rp | T = μN rw= μW rw |
| Rectangular shape of lining: Brand new condition | Variation of lining thickness: Operating condition |
|  | |

**SINGLE PLATE CLUTCH:**

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| --- | --- |
| Case – I: Single Plate Clutch Effective On One Side | Case – I: Single Plate Clutch Effective On Both Side |
| Friction plate is either attached to driving shaft or driven shaft. | Friction plate is not attached to neither driving shaft nor driven shaft. |
| No. of pair of contacting surface (n) = 1 | No. of pair of contacting surface (n) = 2 |

**MULTI PLATE CLUTCH:**

No. of pair of contacting surface (n) = No. of plates – 1 =

Total normal reaction N = nW **and** T = μN r = nμW r (Where, n is positive integer (**real**) number)

**CONE CLUTCH:**

|  |  |
| --- | --- |
| dN = p [2πr / ()] dr, df = μ dN, dT = r df | 2∝ = Cone angle,  ∝ = Semi-Cone angle,  b = face width of friction lining,  W = axial load required for engagement,  N = Normal reaction between the contacting surface, |
| **UNIFORM PRESSURE THEORY** | **UNIFORM WEAR THEORY (Considered for design)** |
| N = p π ()/ sin ∝ |  |
|  | |
| T = μN rp= μW rp/ sin ∝ | T = μN rw= μW rw/ sin ∝ |

Axial load required for engagement (we):

Axial load required for dis-engagement (we):

**What is f’ direction?**

**CENTRIFUGAL CLUTCH:**

|  |  |
| --- | --- |
| n = Number of shoes, | N1 = Speed at which shoe is about to contact hub,  N2 = Speed at which toque is transmitted,  rg = distance between C.G. of shoe and centre of rotation,  rd = distance between centre of rotating shaft and hub surface,  m = mass of each shoe,  T = Total torque transmitted, |
| length of shoe l = θ rd  Radial Pressure (P) = R/wl | θ = Angle subtended by contacting surface of shoe at centre,  w = width of shoe. |

**CVT (CONTINOUS VARIABLE TRANSMISSION)**

**POSITIVE/JAW CLUTCH:**

No slip conditions. Hence its positive clutch.

no heat generation, synchronous speed, Maximum torque transmission.

Teeth’s/ Jaws are made in form of groove for interlocking action.

Shock is observed when it’s Engauge in running condition.

**Square Jaw Clutch:**

Jaws are made of square shape. So, both direction power transition is possible. Can’t Engauge in running condition.

**Spiral jaw clutch:**

Jaws are made of spiral shape. Only one direction power transition is possible. And disengagement is possible in running condition.

Applications: Rolling mills, Presses.