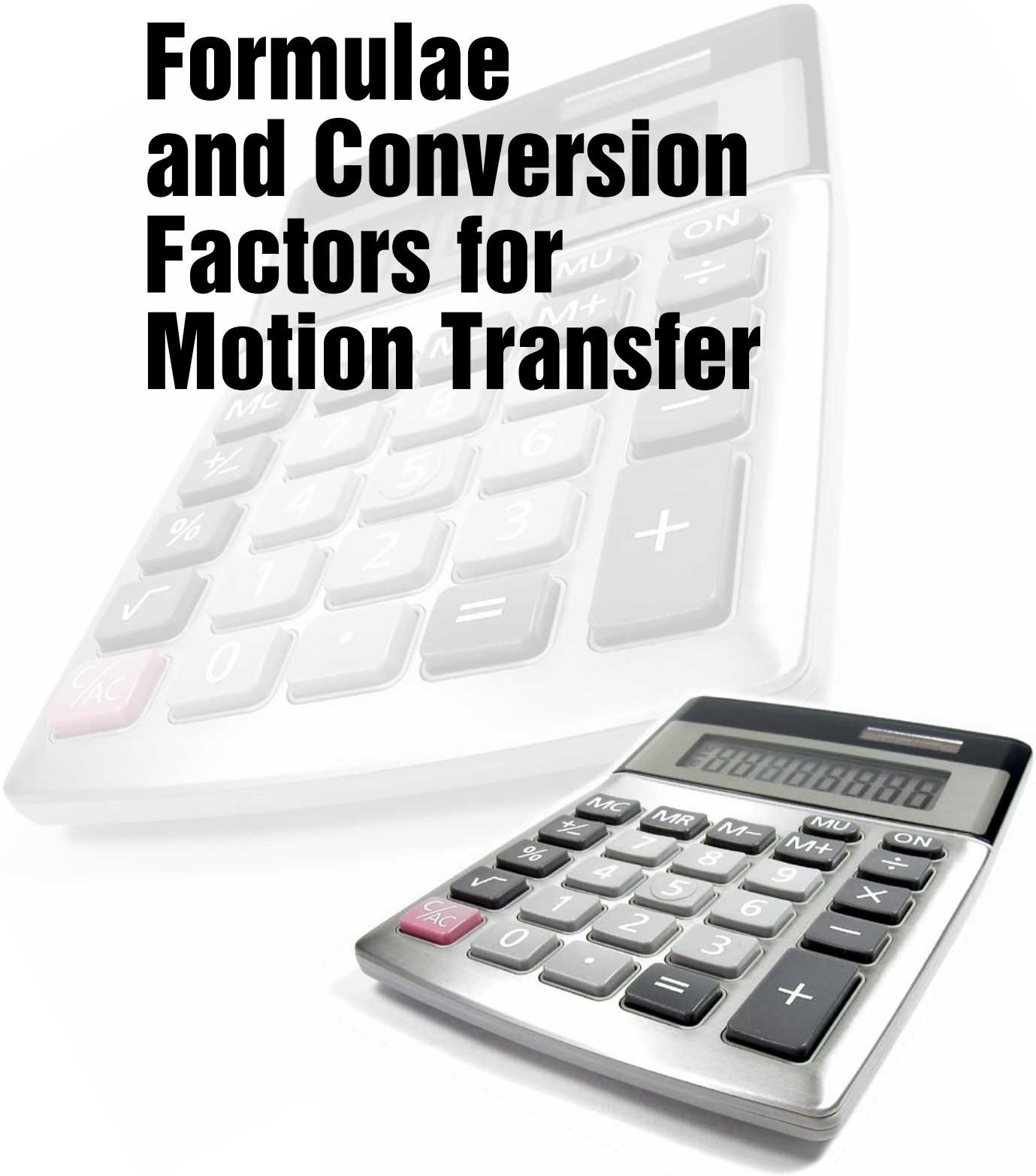
Formulae and Conversion Factors for Motion Transfer



Formulae and Conversion Factors

SI BASE UNITS

Quantity	Unit Symbol	Name
length	m	metre
mass	kg	kilogram
time	s	second
electric current	A	ampere
Thermodynamic temperature	K	kelvin
luminous intensity	cd	candela

LETTER SYMBOLS & SI UNITS IN POWER TRANSMISSION ENGINEERING

Symbol	Quantity	SI Unit Symbol	Name
Mechanics			
E	modulus of elasticity (Young's modulus)	Pa	pascal
F	force	N	Newton
G (W)	weight	N	Newton
J	moment of inertia	kgm2	kilogram metre squared
M (T)	torque	Nm	Newton metre
m	mass	kg	kilogram
P	power	W	watt
p	pressure	Pa	pascal
ρ	density (mas density)	kg/m^3	-
σ	stress	Pa	pascal
W (E)	work (energy)	J	joule
η	efficiency	1	-
μ	coefficient of friction	1	-

FORMULAE

International System(SI) | Imperial System (FPS)

POWER

Lifting motion

$$P = \frac{m \cdot g \cdot v}{\eta \cdot 1000}$$

Linear motion

$$P = \frac{F_r \cdot v}{1000}$$

$$F_r = \mu \cdot m \cdot g$$

Rotary motion

$$P = \frac{M \cdot n}{9550}$$

P - Power in kW
F_r - Frictional resistance in N
m - Mass in kg
g - Acceleration of free fall (9.81) in m/s$_2$
v - Velocity in m/s
η - Efficiency in decimals
μ - Coefficient of friction
M - Torque in Nm
n - Rotational speed in 1/min or r/min

Lifting motion

$$P = \frac{W \cdot v}{\eta \cdot 33000}$$

Linear motion

$$P = \frac{F_r \cdot v}{33000}$$

$$F_r = \mu \cdot W$$

Rotary motion

$$P = \frac{M \cdot n}{5250}$$

P - Power in hp
F_r - Frictional resistance in lbf
W - Weight in lb
v - Velocity in ft/min
η - Efficiency in decimals
μ - Coefficient of friction
M - Torque in lbf . ft
n - Rotational speed in rpm

International System(SI) | Imperial System (FPS)

TORQUE

$$M - F \cdot r$$

$$P = \frac{9550 \cdot P}{n}$$

M - Torque in Nm
F - Force in N
r - Radius of lever in m
P - Power in kW
n - Rotational speed in 1/min or r/min

$$M - F \cdot r$$

$$P = \frac{5250 \cdot P}{n}$$

M - Torque in lbf . ft
F - Force in lbf
r - Radius of lever in ft
P - Power in hp
n - Rotational speed in rpm

WORK

$$W - F \cdot s = m \cdot g \cdot s$$

$$W = \frac{j \cdot n^2}{182.5}$$

W - Work (energy) in Nm = Ws = J
F - Force in N
s - Length of path in m
m - Mass in kg
g - Acceleration of free fall (9.81) in m/s2
J - Moment of inertia in kgm$_2$
n - Rotational speed in 1/min or r/min

$$W - F \cdot s$$

$$W = \frac{WK^2 \cdot n^2}{5880}$$

W - Work (energy) in lb . ft
F - Force in lbf
s - Length of path in ft
m - Mass in kg
g - Acceleration of free fall (9.81) in m/s2
WK$_2$- Flywheel effect lb . ft$_2$
n - Rotational speed in rpm

ACCELERATION OR BRAKING TIME

$$ta = \frac{j \cdot n}{9.55\ M_a}$$

ta - Acceleration or braking time in s
J - Moment of inertia in kgm$_2$
n - Rotational speed in 1/min or r/min
M_a- Acceleration or braking torque in Nm

$$ta = \frac{WK^2 \cdot n}{308\ M_a}$$

ta - Acceleration or braking time in s
WK$_2$- Flywheel effect in kgm$_2$
n - Rotational speed in rpm
M_a- Acceleration or braking torque in lb . ft

MOMENT OF INERTIA

Solid Cylinder

$$J = \frac{1}{2} \cdot m \cdot r^2_{ext}$$

$$= \frac{1}{32} \cdot 1000 \cdot \pi \cdot \rho \cdot l \cdot d^4_{ext}$$

$$= 98\ \rho \cdot l \cdot d^4_{ext}$$

Hollow Cylinder

$$J = \frac{1}{2} \cdot m \cdot (r^2_{ext} + r^2_{int})$$

$$= \frac{1}{32} \cdot 1000 \cdot \pi \cdot \rho \cdot l\ (d^4_{ext} - d^4_{int})$$

$$= 98 \cdot \rho \cdot l\ (d^4_{ext} - d^4_{int})$$

Solid Cylinder

$$WK_2 = \frac{1}{2} \cdot W \cdot r^2_{ext}$$

$$= \frac{\pi}{32} \cdot \rho \cdot l \cdot d^4_{ext}$$

$$= 0.1\ \rho \cdot l \cdot d^4_{ext}$$

Hollow Cylinder

$$WK_2 = \frac{1}{2} \cdot W \cdot (r^2_{ext} + r^2_{int})$$

$$= \frac{\pi}{32} \cdot \rho \cdot l\ (d^4_{ext} - d^4_{int})$$

$$= 0.1 \cdot \rho \cdot l\ (d^4_{ext} - d^4_{int})$$

torsional stiffness and resonant frequency

$$C_T \leq \frac{(F_R \times 2\pi)^2}{\left(\frac{1}{J_M} + \frac{1}{J_L}\right)}$$

$$FR \leq \frac{1}{2\pi} \times \sqrt{\left(\frac{1}{J_M} + \frac{1}{J_L}\right) \times C_T}$$

Where
C_T = *torsional stiffness (Nm/rad);*
J_M = *motor inertia (kgm^2)*
F_R = *resonant frequency (Hz)*
J_L = *load inertia (kgm^2)*

FORCE

		N	kp	p	tonf (UK)	lbf	ozf
1N	=	1	0.1020	102.0	100.4×10^{-6}	0.2248	3.597
1kp	=	9.807	1	1000	0.984×10^{-3}	2.205	35.27
1p	=	9.81×10^{-3}	1×10^{-3}	1	0.984×10^{-6}	2.2×10^{-3}	35.3×10^{-3}
1tonf (UK)	=	9964	1016	1.02×10^{6}	1	2240	35.8×10^{3}
1lbf	=	4.448	0.4536	453.6	0.5×10^{-6}	1	16
1ozf	=	-	28.4×10^{-3}	28.35	27.9×10^{-6}	62.5×10^{-3}	1

VELOCITY

		km/h	m/min	m/s	mile/h	ft/min	ft/s	in/s
1km/h	=	1	16.667	0.2778	0.6214	54.68	0.9113	10.936
m/min	=	0.06	1	16.7×10^{-3}	37.3×10^{-3}	3.281	54.7×10^{-3}	0.656
1m/s	=	3.6	60	1	2.237	196.85	3.281	39.37
1mile/h	=	1.609	26.82	0.4470	1	88	1.467	17.6
1ft/min	=	18.3×10^{-3}	0.3048	5.08×10^{-3}	11.4×10^{-3}	1	16.7×10^{-3}	0.2
1ft/s	=	1.097	18.288	0.3048	0.6818	60	1	12
1in/s	=	91×10^{-3}	1.524	25.4×10^{-3}	56.8×10^{-3}	5	83.3×10^{-3}	1

TORQUE

		Nm	Ncm	kgfm	lbf.ft	lbf.in	ozf.in
1Nm	=	1	100	0.10197	0.73756	8.8507	141.61
Ncm	=	0.01	1	1.02×10^{-3}	7.376×10^{-3}	88.5×10^{-3}	1.4161
1kgfm	=	9.8067	980.67	1	7.233	86.796	1389
1lbf.ft	=	1.356	135.6	0.1383	1	12	192
1lbf.in	=	0.1129	11.29	11.5×10^{-3}	83.3×10^{-3}	1	16
1ozf.in	=	7.062×10^{-3}	0.7062	0.72×10^{-3}	5.21×10^{-3}	62.5×10^{-3}	1

POWER

		kW	PS	hp	kgfm/s	ft.lbf/s
1kW	=	1	1.360	1.341	102.0	737.6
1PS	=	0.7355	1	0.9863	75	542.5
1hp	=	0.7457	1.014	1	76.04	550
1kgfm/s	=	9.81×10^{-3}	13.33×10^{-3}	13.15×10^{-3}	1	7.233
1ft.lbf/s	=	1.36×10^{-3}	1.84×10^{-3}	1.82×10^{-3}	0.1383	1

MOMENT OF INERTIA AND OTHER FLYWHEEL EFFECTS

		kgm^2 (mr^2)	$kgfm^2$ (GD^2)	$lb.ft^2$ (WK^2)	$kpms^2$	ft lbf s^2
$1kgm^2$ (mr^2)	=	1	4	23.73	0.102	0.7376
$1kgfm^2$ (GD^2)	=	0.25	1	5.933	25×10^{-3}	0.1844
$1lb.ft^2$ (WK^2)	=	42.1×10^{-3}	0.1686	1	4.30×10^{-3}	31.1×10^{-3}
$1kpms^2$	=	9.807	39.23	232.7	1	7.233
1ft lbf s^2	=	1.356	5.423	32.17	0.1383	1

LENGTH

	mm	m	in	ft	yds	km	miles
1mm	1	0.001	0.3937	0.0033	0.00109	-	-
1m	1000	1	39.370	3.2808	1.0936	0.001	0.0006215
1in	25.4	0.0254	1	0.0833	0.0277	0.0000254	0.0000158
1ft	304.8	0.3048	12	1	0.3333	0.000304	0.0001894
1yd	914.4	0.9144	36	3	1	0.000914	0.000568
1km	-	1000	39,370.07	3,280.83	1,093.613	1	0.6215
1mile	-	1,609	63,346.45	5,278.87	1,759.623	1.609	1