Important Kinetics of Motion Formulas PDF

Formulas
Examples
with Units

List of 25
Important Kinetics of Motion Formulas

1) Kinetics Formulas

1.1) Angular Acceleration of Shaft B given Gear Ratio and Angular Acceleration of Shaft A Formula

Evaluate Formula

Formula

$$\alpha_B = G \cdot \alpha_A$$

Example

$$75 = 3 \cdot 25$$

1.2) Angular Velocity given Speed in RPM Formula

Evaluate Formula

Formula

$$\omega = \frac{2 \cdot \pi \cdot N_A}{60}$$

Example with Units

$$11.205\,\text{rad/s} = \frac{2 \cdot 3.1416 \cdot 107}{60}$$

1.3) Centripetal Force or Centrifugal Force for given Angular Velocity and Radius of Curvature Formula

Evaluate Formula

Formula

$$Fc = Mass_{\text{flight path}} \cdot \omega^2 \cdot R_c$$

Example with Units

$$66702.72\,\text{N} = 35.45\,\text{kg} \cdot 11.2\,\text{rad/s}^2 \cdot 15\,\text{m}$$

1.4) Coefficient of Restitution Formula

Evaluate Formula

Formula

$$e = \frac{v_1 - v_2}{u_2 - u_1}$$

Example with Units

$$0.8333 = \frac{12\,\text{m/s} - 8\,\text{m/s}}{10\,\text{m/s} - 5.2\,\text{m/s}}$$

1.5) Efficiency of Machine Formula

Evaluate Formula

Formula

$$\eta = \frac{P_{out}}{P_{in}}$$

Example with Units

$$0.82 = \frac{37.72\,\text{W}}{46\,\text{W}}$$

1.6) Equivalent Mass Moment of Inertia of Geared System with Shaft A and Shaft B Formula

Evaluate Formula

Formula

$$MOI = I_A + \frac{G^2 \cdot I_B}{\eta}$$

Example with Units

$$413.122\,\text{kg·m}^2 = 18\,\text{kg·m}^2 + \frac{3^2 \cdot 36\,\text{kg·m}^2}{0.82}$$

1.7) Final Velocity of Bodies A and B after Inelastic Collision Formula

Evaluate Formula

Formula

$$v = \frac{m_1 \cdot u_1 + m_2 \cdot u_2}{m_1 + m_2}$$

Example with Units

$$6.6667\,\text{m/s} = \frac{30\,\text{kg} \cdot 5.2\,\text{m/s} + 13.2\,\text{kg} \cdot 10\,\text{m/s}}{30\,\text{kg} + 13.2\,\text{kg}}$$

1.8) Gear Ratio when Two Shafts A and B are Geared Together Formula

Evaluate Formula

Formula

$$G = \frac{N_B}{N_A}$$

Example

$$3 = \frac{321}{107}$$

1.9) Impulse Formula

Evaluate Formula

Formula

$$i = F \cdot t$$

Example with Units

$$12.5\,\text{kg*m/s} = 2.5\,\text{N} \cdot 5\,\text{s}$$

1.10) Impulsive Force Formula

Evaluate Formula

Formula

$$F_{impulsive} = \frac{\text{Mass}_{flight\ path} \cdot \left(v_f - u\right)}{t}$$

Example with Units

$$36.159\,\text{N} = \frac{35.45\,\text{kg} \cdot \left(40.1\,\text{m/s} - 35\,\text{m/s}\right)}{5\,\text{s}}$$

1.11) Kinetic Energy of System after Inelastic Collision Formula

Evaluate Formula

Formula

$$E_k = \frac{\left(m_1 + m_2\right) \cdot v^2}{2}$$

Example with Units

$$958.081\,\text{J} = \frac{\left(30\,\text{kg} + 13.2\,\text{kg}\right) \cdot 6.66\,\text{m/s}^2}{2}$$

1.12) Loss of Kinetic Energy during Imperfect Elastic Impact Formula

Evaluate Formula

Formula

$$E_{L\,elastic} = E_{L\,inelastic} \cdot \left(1 - e^2\right)$$

Example with Units

$$32.8522\,\text{J} = 105.6\,\text{J} \cdot \left(1 - 0.83^2\right)$$

1.13) Loss of Kinetic Energy during Perfectly Inelastic Collision Formula

Evaluate Formula

Formula

$$E_{L\,inelastic} = \frac{m_1 \cdot m_2 \cdot \left(u_1 - u_2\right)^2}{2 \cdot \left(m_1 + m_2\right)}$$

Example with Units

$$105.6\,\text{J} = \frac{30\,\text{kg} \cdot 13.2\,\text{kg} \cdot \left(5.2\,\text{m/s} - 10\,\text{m/s}\right)^2}{2 \cdot \left(30\,\text{kg} + 13.2\,\text{kg}\right)}$$

1.14) Overall Efficiency from Shaft A to X Formula

Evaluate Formula

Formula

$$\eta_x = \eta^m$$

Example

$$0.0343 = 0.82^{17}$$

1.15) Power Loss Formula

Evaluate Formula

Formula

$$P_{loss} = P_{in} - P_{out}$$

Example with Units

$$8.28\,\text{W} = 46\,\text{W} - 37.72\,\text{W}$$

1.16) Speed of Guide Pulley Formula

Evaluate Formula

Formula

$$N_P = N_D \cdot \frac{d}{d_1}$$

Example with Units

$$50.3483\,\text{rev/min} = 44\,\text{rev/min} \cdot \frac{23\,\text{m}}{20.1\,\text{m}}$$

1.17) Total Kinetic Energy of Geared System Formula

Evaluate Formula

Formula

$$KE = \frac{MOI \cdot \alpha_A^{\,2}}{2}$$

Example with Units

$$129100.625\,\text{J} = \frac{413.122\,\text{kg·m²} \cdot 25^{\,2}}{2}$$

2) Torque on Shaft Formulas

2.1) Impulsive Torque Formula

Evaluate Formula

Formula

$$T_{impulsive} = \frac{I \cdot \left(\omega_1 - \omega\right)}{t}$$

Example with Units

$$8.865\,\text{N*m} = \frac{1.125\,\text{kg·m²} \cdot \left(50.6\,\text{rad/s} - 11.2\,\text{rad/s}\right)}{5\,\text{s}}$$

2.2) Torque on Shaft A to Accelerate Shaft B Formula

Evaluate Formula

Formula

$$T_{AB} = G^2 \cdot I_B \cdot \alpha_A$$

Example with Units

$$8100\,\text{N*m} = 3^2 \cdot 36\,\text{kg·m²} \cdot 25$$

2.3) Torque on Shaft A to Accelerate Shaft B given Gear Efficiency Formula

Evaluate Formula

Formula

$$T_{AB} = \frac{G \cdot I_B \cdot \alpha_A}{\eta}$$

Example with Units

$$3292.6829\,\text{N*m} = \frac{3 \cdot 36\,\text{kg·m²} \cdot 25}{0.82}$$

2.4) Torque on Shaft B to Accelerate Itself given Gear Ratio Formula

Evaluate Formula

Formula

$$T_B = G \cdot I_B \cdot \alpha_A$$

Example with Units

$$2700\,\text{N*m} = 3 \cdot 36\,\text{kg·m²} \cdot 25$$

2.5) Torque on Shaft B to Accelerate Itself given M.I and Angular Acceleration Formula

Evaluate Formula

Formula

$$T_B = I_B \cdot \alpha_B$$

Example with Units

$$2700\,\text{N*m} = 36\,\text{kg·m²} \cdot 75$$

2.6) Torque required on Shaft A to Accelerate Itself given M.I of A and Angular Acceleration of Shaft A Formula

Evaluate Formula

Formula

$$T_A = I_A \cdot \alpha_A$$

Example with Units

$$450\,\text{N*m} = 18\,\text{kg·m²} \cdot 25$$

2.7) Total Torque Applied to Accelerate Geared System given Ta and Tab Formula

Evaluate Formula

Formula

$$T = T_A + T_{AB}$$

Example with Units

$$8550\,\text{N*m} = 450\,\text{N*m} + 8100\,\text{N*m}$$

2.8) Total Torque Applied to Shaft A to Accelerate Geared System Formula

Evaluate Formula

Formula

$$T = \left(I_A + G^2 \cdot I_B \right) \cdot \alpha_A$$

Example with Units

$$8550\,\text{N*m} = \left(18\,\text{kg·m²} + 3^2 \cdot 36\,\text{kg·m²} \right) \cdot 25$$

Variables used in list of Kinetics of Motion Formulas above

- **d** Diameter of Drum Pulley *(Meter)*
- d_1 Diameter of Guide Pulley *(Meter)*
- **e** Coefficient of Restitution
- E_k Kinetic Energy of System After Inelastic Collision *(Joule)*
- $E_{L\ elastic}$ Loss of Kinetic Energy During an Elastic Collision *(Joule)*
- $E_{L\ inelastic}$ Loss of K.E During Perfectly Inelastic Collision *(Joule)*
- **F** Force *(Newton)*
- $F_{impulsive}$ Impulsive Force *(Newton)*
- **Fc** Centripetal Force *(Newton)*
- **G** Gear Ratio
- **i** Impulse *(Kilogram Meter per Second)*
- **I** Moment of Inertia *(Kilogram Square Meter)*
- I_A Mass Moment of Inertia of Mass Attached to Shaft A *(Kilogram Square Meter)*
- I_B Mass Moment of Inertia of Mass Attached to Shaft B *(Kilogram Square Meter)*
- **KE** Kinetic Energy *(Joule)*
- **m** Total no. of Gear Pairs
- m_1 Mass of Body A *(Kilogram)*
- m_2 Mass of Body B *(Kilogram)*
- $Mass_{flight\ path}$ Mass *(Kilogram)*
- **MOI** Equivalent Mass of Geared System *(Kilogram Square Meter)*
- N_A Speed of Shaft A in RPM
- N_B Speed of Shaft B in RPM
- N_D Speed of Drum Pulley *(Revolution per Minute)*
- N_P Speed of Guide Pulley *(Revolution per Minute)*
- P_{in} Input Power *(Watt)*
- P_{loss} Power Loss *(Watt)*
- P_{out} Output Power *(Watt)*

Constants, Functions, Measurements used in list of Kinetics of Motion Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Weight** in Kilogram (kg) *Weight Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion*
- Measurement: **Energy** in Joule (J) *Energy Unit Conversion*
- Measurement: **Power** in Watt (W) *Power Unit Conversion*
- Measurement: **Force** in Newton (N) *Force Unit Conversion*
- Measurement: **Frequency** in Revolution per Minute (rev/min) *Frequency Unit Conversion*
- Measurement: **Angular Velocity** in Radian per Second (rad/s) *Angular Velocity Unit Conversion*
- Measurement: **Torque** in Newton Meter (N*m) *Torque Unit Conversion*
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²) *Moment of Inertia Unit Conversion*
- Measurement: **Momentum** in Kilogram Meter per Second (kg*m/s) *Momentum Unit Conversion*

- R_c Radius of Curvature *(Meter)*
- **t** Time Taken to Travel *(Second)*
- **T** Total Torque *(Newton Meter)*
- T_A Torque Required on Shaft A to Accelerate Itself *(Newton Meter)*
- T_{AB} Torque Applied on Shaft A to Accelerate Shaft B *(Newton Meter)*
- T_B Torque Required on Shaft B to Accelerate Itself *(Newton Meter)*
- $T_{impulsive}$ Impulsive Torque *(Newton Meter)*
- **u** Initial Velocity *(Meter per Second)*
- u_1 Initial Velocity of Body A Before the Collision *(Meter per Second)*
- u_2 Initial Velocity of Body B Before the Collision *(Meter per Second)*
- **v** Final Speed of A and B After Inelastic Collision *(Meter per Second)*
- v_1 Final Velocity of Body A After Elastic Collision *(Meter per Second)*
- v_2 Final Velocity of Body B After Elastic Collision *(Meter per Second)*
- v_f Final Velocity *(Meter per Second)*
- α_A Angular Acceleration of Shaft A
- α_B Angular Acceleration of Shaft B
- η Gear Efficiency
- η_x Overall Efficiency from Shaft A to X
- ω Angular Velocity *(Radian per Second)*
- ω_1 Final Angular Velocity *(Radian per Second)*

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