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Kinetics of Motion Formulas

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List of 25 Kinetics of Motion Formulas

Kinetics of Motion

Kinetics

1) Angular Acceleration of Shaft B given Gear Ratio and Angular Acceleration of Shaft A

Open Calculator

fx $\alpha_B = G \cdot \alpha_A$

ex $75 = 3 \cdot 25$

2) Angular Velocity given Speed in RPM

Open Calculator

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

ex $11.20501\text{rad/s} = \frac{2 \cdot \pi \cdot 107}{60}$

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

Open Calculator

fx $Fc = \text{Mass}_{\text{flight path}} \cdot \omega^2 \cdot R_c$

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

4) Coefficient of Restitution

Open Calculator

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

ex $$0.833333 = \frac{12\text{m/s} - 8\text{m/s}}{10\text{m/s} - 5.2\text{m/s}}$$

5) Efficiency of Machine

Open Calculator

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

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

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

Open Calculator

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

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

7) Final Velocity of Bodies A and B after Inelastic Collision

Open Calculator

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

ex $$6.666667\text{m/s} = \frac{30\text{kg} \cdot 5.2\text{m/s} + 13.2\text{kg} \cdot 10\text{m/s}}{30\text{kg} + 13.2\text{kg}}$$

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

Open Calculator

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

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

9) Impulse

Open Calculator

fx $$i = F \cdot t$$

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

10) Impulsive Force

Open Calculator

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

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

11) Kinetic Energy of System after Inelastic Collision

Open Calculator

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

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

12) Loss of Kinetic Energy during Imperfect Elastic Impact

Open Calculator

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

ex $$32.85216\text{J} = 105.6\text{J} \cdot \left(1 - (0.83)^2\right)$$

13) Loss of Kinetic Energy during Perfectly Inelastic Collision

Open Calculator

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

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

14) Overall Efficiency from Shaft A to X

Open Calculator

fx $$\eta_x = \eta^m$$

ex $$0.034264 = (0.82)^{17}$$

15) Power Loss

Open Calculator

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

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

16) Speed of Guide Pulley

Open Calculator

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

ex $$50.34826\text{rev/min} = 44\text{rev/min} \cdot \frac{23\text{m}}{20.1\text{m}}$$

17) Total Kinetic Energy of Geared System

Open Calculator

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

ex $$129100.6\text{J} = \frac{413.122\text{kg·m}^2 \cdot (25)^2}{2}$$

Torque on Shaft

18) Impulsive Torque

Open Calculator

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

ex $$8.865\text{N*m} = \frac{1.125\text{kg·m}^2 \cdot (50.6\text{rad/s} - 11.2\text{rad/s})}{5\text{s}}$$

19) Torque on Shaft A to Accelerate Shaft B

Open Calculator

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

ex $$8100\text{N*m} = (3)^2 \cdot 36\text{kg·m}^2 \cdot 25$$

20) Torque on Shaft A to Accelerate Shaft B given Gear Efficiency

Open Calculator

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

ex $$3292.683\text{N*m} = \frac{3 \cdot 36\text{kg·m}^2 \cdot 25}{0.82}$$

21) Torque on Shaft B to Accelerate Itself given Gear Ratio

Open Calculator

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

ex $$2700\text{N*m} = 3 \cdot 36\text{kg·m}^2 \cdot 25$$

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

Open Calculator

fx $$T_B = I_B \cdot \alpha_B$$

ex $$2700\text{N*m} = 36\text{kg·m}^2 \cdot 75$$

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

Open Calculator

fx $$T_A = I_A \cdot \alpha_A$$

ex $$450\text{N*m} = 18\text{kg·m}^2 \cdot 25$$

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

Open Calculator

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

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

25) Total Torque Applied to Shaft A to Accelerate Geared System

Open Calculator

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

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

Variables Used

- **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)*
- 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)*

Constants, Functions, Measurements used

- Constant: **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

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