Chapter 9

Angular Velocity and Acceleration	
Θ = angle (radians)	s = length
r = radius	$90^o = \pi/2$ rad
$\Theta = (s/r)$	$s = r \cdot \Theta$
1 rad = $(360^o / 2\pi) = 57.3^o$	$180^o = \pi$ rad
Angular Velocity	(1st Derivative)
$\omega = (\Theta_f - \Theta_i) / (t_f - t_i)$	ω = "velocity"
1 rev/s = 2π rad/s	1 rev/min = 1 rpm = $2\pi/60$ rad/s
Angular Acceleration	(2nd Derivative)
$\alpha = (\omega_f - \omega_i) / (t_f - t_i)$	α = "acceleration"
Rotation w/ Constant Angular Acceleration	
$\alpha_f = (\omega_f - \omega_i) / (t - 0)$	α_f = constant
$\omega_f = \omega_i + \alpha_f \cdot t$	
$\Theta_f - \Theta_i = 1/2(\omega_i + \omega_f) \cdot t$	
$\Theta_f = \Theta_i + (\omega_i \cdot t) + 1/2\,(\alpha_f \cdot t^2)$	
$\omega_f^2 = \omega_i^2 + 2 \cdot \alpha_f(\Theta_f - \Theta_i)$	
Relating Linear and Angular Kinematics	$K = 1/2(m \cdot v^2)$
Linear Speed in Rigid-Body Rotation	$s = r \cdot \Theta$
Linear Speed	$v = r \cdot \omega$
Linear Acceleration in Rigid-Body Rotation	$a_{tan} = r \cdot \alpha$
Centripetal Component of Acceleration	$a_{rad} = (v^2/r) = \omega^2 \cdot r$
Energy in Rotational Motion	K_E: $1/2 \cdot m \cdot v^2 = 1/2 \cdot m \cdot r^2 \cdot \omega^2$
$K = 1/2 \cdot m \cdot r^2 \cdot \omega^2$	$I = m \cdot r^2$
Gravitational Potential Energy for an Extended Body	$U = M \cdot g \cdot y_{cm}$

Chapter 9 (cont)

Moment of Inertia	$I_p = I_{cm} + Md^2$

Chapter 9 Cont:

Rotational Kinetic Energy	K = Joules
$K = 1/2 \cdot I \cdot \omega^2$	R = Radius
M = mass pivoted about an axis	
Perpendicular to the Rod	$I = (M \cdot L^2) / 3$
Slender Rod (Axis Center)	$I = 1/12M \cdot L^2$
Slender Rod (Axis End)	$I = 1/3M \cdot L^2$
Rectangular Plate (Axis Center)	$I = 1/12M \cdot (a^2+b^2)$
Rectangular Plate (Axis End)	$I = 1/3M \cdot (a^2)$
Hallow Cylinder	$I = 1/2M(R_i^2 + R_f^2)$
Solid Cylinder	$I = 1/2MR^2$
Hollow Cylinder (Thin)	$I = MR^2$
Solid Sphere	$I = 2/5MR^2$
Hollow Sphere (Thin)	$I = 2/3MR^2$

Chapter 11: Equilibrium and Elasticity

1st Condition of Equilibrium (at rest)	$\Sigma F = 0$
2nd Condition of Equilibrium (nonrotating)	$\Sigma \tau = 0$
Center of Gravity	$r_{cm} = (m_1 \cdot r_1) / m_1$
Solving Rigid-Body Equilibrium Problems	$\Sigma F_x = 0$
1st Condition	$\Sigma F_x = 0$ $\Sigma F_y = 0$
2nd Condition (Forces xy-plane)	$\Sigma \tau_z = 0$

Chapter 11: Equilibrium and Elasticity (cont)

Stress, Strain, and Elastic Moduli	Stress = Force Applied to deform a body Strain = how much deformation
Hooke's Law	(Stress / Strain) = Elastic Modulus
A = Area	F = Magnitude of Force
Tensile Stress	F / A
1 Pascal = Pa = 1 N/m^2	1 psi = 6895 Pa
l = length	1 Pa = $1.450 \cdot 10^4$
Tensile Strain	$(l_f - l_i) / (l_i)$
Young Modulus	(Tensile Stress) / (Tensile Strain)
Pressure	p = F (Force Fluid is Applied) / A (Area which force is exerted)
Bulk Stress	$(p_f - p_i)$
Bulk Strain	$(V_f - V_i) / (V_i)$
Bulk Modulus	Bulk Stress / Bulk Strain

Chapter 10: Dynamics of Rotational Motion

Torque	
F = Magnitude of F	$\|\| \|\|$ = Magnitude Symbol
$\tau = F \cdot l = r \cdot F \cdot \sin\Theta = F_{tan} r$	L = lever arm of F
$\tau = \|\|r\|\| \times \|\|F\|\|$	
Torque and Angular Acceleration for a Rigid Body	
Newtons 2nd Law of Tangential Component	$F_{tan} = m_1 \cdot a_1$
Rotational analog of Newton's second law for a rigid body	
$\Sigma \tau_z = I \cdot \alpha_z$	z = rigid body about z-axis

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Chapter 10: Dynamics of Rotational Motion (cont)

Combined Translation and Rotation: Energy Relationships	
$K = 1/2 M \cdot v^2 + 1/2 \cdot I \cdot \omega^2$	
Rolling without Slipping	$v = R \cdot \omega$
Combined Translation and Rotation: Dynamics	
Rotational Motion about the center of mass	$\Sigma \tau_z = I \cdot \alpha_z$
Work and Power in Rotational Motion	$F = M \cdot a$
When it rotates from Θ_i to Θ_f	$W = \int (\Theta_f$ to $\Theta_i)\ \tau_f\ d\Theta$
When the torque remains constant while angle changes	$W = \tau_f(\Theta_f$ to $\Theta_i)$
Total WorkDone on rotating rigid body	$W = 1/2(\omega_f^2) - 1/2(\omega_i^2)$
Power due to torque on rigid body	$P = \tau_z \cdot \omega_z$
Angular Momentum	$L = r \times p\ (r \times m \cdot v)$
Angular Momentum of a Rigid Body	$L = m_i \cdot r_i^2 \cdot \omega$

Chapter 11: Equilibrium and Elasticity (cont.)

	F = Force acting tangent to the surface divided by the Area
Shear Stress	F / A
h = transverse dimension [bigger]	x = relative displacement (empty) [smaller]
Shear Strain	x / h

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