PS 160 – Physics II for Engineers
Exam #1 Review
Chapters 9, 10, 11, 12

ROTATIONAL MOTION

Angular variables: $\theta = \frac{s}{r}$ $\omega = \frac{d\theta}{dt} = \frac{v_t}{r}$ $\alpha = \frac{d\omega}{dt} = \frac{a_t}{r}$

Kinematic equations: $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ $\omega = \omega_0 + \alpha t$

ROTATIONAL DYNAMICS

Torque: $\vec{\tau} = \vec{r} \times \vec{F}$ where $\vec{A} \times \vec{B} = AB\sin\theta$ (right-hand rule)

Moment of inertia: $I = \sum_i m_i r_i^2 = \int r^2 dm$ parallel axis theorem: $I = I_{cm} + Md^2$

Rotational kinetic energy: $K = \frac{1}{2} I\omega^2$ rolling without slipping: $v_{cm} = R\omega$

Newton's second law: $\sum \vec{\tau} = I\vec{\alpha}$

Angular momentum: $\vec{L} = \vec{r} \times \vec{p} = I\vec{\omega}$ conserved if no external torque

EQUILIBRIUM

Two conditions: $\sum \vec{F} = 0$ $\sum \vec{\tau} = 0$

ELASTICITY:

modulus = stress/strain

Tensile/compressive (Young's modulus): $Y = \frac{F_\perp / A}{\Delta\ell / \ell_0}$

Bulk (Bulk modulus): $B = -\frac{\Delta p}{\Delta V / V_0}$ pressure: $p = F_\perp / A$

Shear (Shear modulus): $S = \frac{F_\parallel / A}{x / h}$

GRAVITY

Newton's law of gravitation: $F_{12} = \frac{Gm_1 m_2}{r_{12}^2}$ attractive

Potential energy of *m* due to Earth: $U = -\frac{GM_E m}{r}$

Orbital motion (Kepler's third law): $v^2 r = GM$ or $\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$