**EART160: Equations You Should Know** (in addition to high school physics)

### Gravity and impacts

**Newton’s law**  \[ F = GMm/r^2 \]  
Surface gravity  \[ g = GM/R^2 \]

**Escape velocity**  \[ v = (2gR)^{1/2} \]  
Gravitational potential  \[ U = -GM/r \]

**Orbital period**  \[ GM = a^3 \omega^2 \]

### Flexure and Stresses

**Hooke’s law**  \[ \sigma = E\varepsilon \]  
Thermal expansion  \[ \varepsilon = \alpha \Delta T \]

**Flexural parameter**  \[ \alpha = \left( \frac{ET_e^3}{3g\Delta\rho(l - v^2)} \right)^{1/4} \]

### Interiors

**Hydrostatic assumption**  \[ dP = (-)\rho gdz \]  
Heat flow  \[ F = k \frac{dT}{dz} \]

**Specific heat capacity**  \[ E = mC_p\Delta T \]  
Rayleigh number  \[ Ra = \frac{\rho g \alpha \Delta T d^3}{\kappa \eta} \]

**Thermal diffusivity**  \[ \kappa = k/\rho C_p \]  
Diffusion timescale  \[ t = d^2/\kappa \]

### Atmospheres

**Black-body radiation**  \[ F = \varepsilon \sigma T^4 \]  
Gas law  \[ PV = P\mu /\rho = RT \]

**Scale height**  \[ H = RT/g\mu \]  
Coriolis acceleration  \[ a = 2v\omega \sin \theta \]

### Gravity and Tides

**Angular momentum**  \[ L = I\omega \]  
Moment of inertia  \[ I = \int r^2 dm = \sum mr^2 \]

**Kinetic energy of rotation**  \[ E = I\omega^2/2 \]  

**Orbital period**  \[ GM = a^3 \omega^2 \]  
Orbital energy  \[ E = -GMm/2a \]

**Equilibrium tide (fluid body)**  \[ H = \frac{5}{2} R \frac{M}{m} \left( \frac{R}{a} \right)^3 \]  
\( M \) is the mass of the tide-raising body