

# PHY 3110: Classical Mechanics

## Midterm Exam 2 Formula Sheet

$$\begin{aligned}
 m\ddot{\mathbf{r}}_\alpha &= \mathbf{F}_\alpha \\
 m\left(\ddot{r} - r\dot{\phi}^2\right) &= F_r \\
 m\left(r\ddot{\phi} + 2\dot{r}\dot{\phi}\right) &= F_\phi \\
 m\dot{\mathbf{v}} &= -v_{ex}\dot{m} + \mathbf{F}^{\text{ext}} \\
 \mathbf{r} &= x\hat{\mathbf{x}} + y\hat{\mathbf{y}} = r\hat{\mathbf{r}} \\
 x &= r\cos\phi \quad y = r\sin\phi \quad x^2 + y^2 = r^2 \\
 \dot{x}^2 + \dot{y}^2 &= \dot{r}^2 + r^2\dot{\phi}^2 \\
 \frac{\partial f}{\partial y} &= \frac{d}{dx} \frac{\partial f}{\partial y'} \quad (\text{for } f = f(y, y', x)) \\
 f - y' \frac{\partial f}{\partial y'} &= \text{constant} \quad (\text{if } f = f(y, y')) \\
 U_{\text{eff}}(r) &= U(r) + \frac{\ell^2}{2\mu r^2} \\
 m\ddot{\mathbf{r}} &= \sum \mathbf{F} - m\mathbf{A}_0 - m\boldsymbol{\Omega} \times (\boldsymbol{\Omega} \times \mathbf{r}) - 2m\boldsymbol{\Omega} \times \mathbf{v}.
 \end{aligned}$$

Mathematical results which may or may not be helpful:

$$\begin{aligned}
 (1+x)^\alpha &= 1 + \alpha x + \frac{\alpha(\alpha-1)}{2}x^2 + \dots (|x| < 1) \\
 e^x &= 1 + x + \frac{x^2}{2} + \frac{x^3}{3!} + \dots \\
 e^{i\theta} &= \cos\theta + i\sin\theta \\
 \int u^\alpha du &= \frac{1}{\alpha+1}u^{\alpha+1} + C \quad (\alpha \neq -1) \\
 \int \frac{du}{u} &= \ln u + C \\
 \int e^u du &= e^u + C \\
 \frac{du}{dt} &= \frac{du}{dz} \frac{dz}{dt}
 \end{aligned}$$

For  $ax^2 + bx + c = 0$ ,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$