PHY 3110: Classical Mechanics
Midterm Exam 2 Formula Sheet

$$
\begin{aligned}
m\ddot{\mathbf{r}}_\alpha &= \mathbf{F}_\alpha \\
m\left(\ddot{r} - r\dot{\phi}^2\right) &= F_r \\
m\left(r\ddot{\phi} + 2\dot{r}\dot{\phi}\right) &= F_\phi \\
m\dot{v} &= -v_{ex}\dot{m} + F^{\text{ext}} \\
\mathbf{r} &= x\hat{\mathbf{x}} + y\hat{\mathbf{y}} = r\hat{\mathbf{r}} \\
x &= r\cos\phi \qquad y = r\sin\phi \qquad x^2 + y^2 = r^2 \\
\frac{\partial f}{\partial y} &= \frac{d}{dx}\frac{\partial f}{\partial y'} \qquad (\text{for } f = f(y, y', x)) \\
f - y'\frac{\partial f}{\partial y'} &= \text{constant} \qquad (\text{if } f = f(y, y'))
\end{aligned}
$$

Mathematical results which may or may not be helpful:

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

For arbitrary functions of time $p(t)$, $q(t)$

$$
\frac{dy}{dt} + p(t)y(t) = q(t) \qquad \Rightarrow \qquad \frac{d}{dt}\left[I(t)y(t)\right] = I(t)q(t),
$$

where $I(t) = \exp\left[\int q(t)dt\right]$.

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

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