ATM 316 Midterm Exam #1 SAMPLE EQUATION SHEET

Fall, 2020 – Fovell

Some useful information

- **Show work and draw pictures whenever possible.** Show your steps. I can't give partial credit unless I can figure out what you were doing. **Answers without work or justification have no value.**
- **If you cannot answer a particular question owing to insufficient information, state what information you need to answer it. If you cannot answer it for any other reason, give me something I can use to possibly justify some partial credit.**
- Some equations:

$\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}| \cos\theta$

$\vec{A} \times \vec{B} = |\vec{A}||\vec{B}| \sin\theta \ \hat{n}$

$\frac{\partial f(x_0)}{\partial x} \approx \frac{f(x_0+\Delta x)-f(x_0-\Delta x)}{2\Delta x}$

$\frac{\partial^2 f(x_0)}{\partial x^2} \approx \frac{f(x_0+\Delta x)-2f(x_0)+f(x_0-\Delta x)}{\Delta x^2}$

$\nabla A = \frac{\partial A}{\partial x}\hat{i} + \frac{\partial A}{\partial y}\hat{j} + \frac{\partial A}{\partial z}\hat{k}$

$\vec{U} = u\hat{i} + v\hat{j} + w\hat{k}$

$\nabla \cdot \vec{U} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}$

$\nabla \times \vec{U} = (\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z})\hat{i} - (\frac{\partial w}{\partial x} - \frac{\partial u}{\partial z})\hat{j} + (\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y})\hat{k}$

$\frac{dB}{dt} = \frac{\partial B}{\partial t}\frac{dt}{dt} + \frac{\partial B}{\partial x}\frac{dx}{dt} + \frac{\partial B}{\partial y}\frac{dy}{dt} + \frac{\partial B}{\partial z}\frac{dz}{dt} = \frac{\partial B}{\partial t} + \vec{U} \cdot \nabla B$

PGF (per unit mass): $-\frac{1}{\rho}\nabla p$

$p = \rho R T$

$F_{gravity} = -\frac{GMm}{|\vec{r}|^2}\left[\frac{\vec{r}}{|\vec{r}|}\right]$

$\vec{V}_{tan} = \omega \vec{R}$

$f = 2\Omega \sin\phi$

$\vec{\Omega} = \Omega\cos\phi\hat{j} + \Omega\sin\phi\hat{k}$

$(\frac{d\vec{U}}{dt})_{Coriolis} = -2\vec{\Omega} \times \vec{U}$

- Some constants and conversions (subscript "d" for dry air):

$R_d = 287$ J kg^{-1} K^{-1}; $c_{pd} = 1004$ J kg^{-1} K^{-1}; $c_{vd} = 717$ J kg^{-1} K^{-1}

$g_0 = g = 9.81$ m s^{-2} (Using 10 m s^{-2} is OK.)

$\epsilon = 0.622$

1 mb = 100 Pa.

$\Omega = 7.292 \times 10^{-5}$ s^{-1}

Earth radius = 6371 km.