MA 16020 – EXAM FORMULAS

THE SECOND DERIVATIVE TEST
Suppose $f$ is a function of two variables $x$ and $y$, and that all the second-order partial derivatives are continuous. Let

$$d = f_{xx}f_{yy} - (f_{xy})^2$$

and suppose $(a, b)$ is a critical point of $f$.
1. If $d(a, b) > 0$ and $f_{xx}(a, b) > 0$, then $f$ has a relative minimum at $(a, b)$.
2. If $d(a, b) > 0$ and $f_{xx}(a, b) < 0$, then $f$ has a relative maximum at $(a, b)$.
3. If $d(a, b) < 0$, then $f$ has a saddle point at $(a, b)$.
4. If $d(a, b) = 0$, the test is inconclusive.

LAGRANGE EQUATIONS
For the function $f(x, y)$ subject to the constraint $g(x, y) = c$, the Lagrange equations are

$$f_x = \lambda g_x \quad f_y = \lambda g_y \quad g(x, y) = c$$

GEOMETRIC SERIES
If $0 < |r| < 1$, then

$$\sum_{n=0}^{\infty} ar^n = \frac{a}{1 - r}$$

VOLUME & SURFACE AREA

**Right Circular Cylinder**
\[ V = \pi r^2 h \]
\[ SA = \begin{cases} 2\pi r^2 + 2\pi rh \\ \pi r^2 + 2\pi rh \end{cases} \]

**Sphere**
\[ V = \frac{4}{3} \pi r^3 \]
\[ SA = 4\pi r^2 \]

**Right Circular Cone**
\[ V = \frac{1}{3} \pi r^2 h \]
\[ SA = \pi r \sqrt{r^2 + h^2} + \pi r^2 \]