Unless otherwise stated in the examination question, assume:

- The market is frictionless. There are no taxes, transaction costs, bid/ask spreads or restrictions on short sales. All securities are perfectly divisible. Trading does not affect prices. Information is available to all investors simultaneously. Every investor acts rationally and there are no arbitrage opportunities.
- The risk-free interest rate is constant.
- The notation is the same as used in *Derivatives Markets*, by Robert L. McDonald.

When using the normal distribution calculator, values should be entered with five decimal places. Use all five decimal places from the result in subsequent calculations.

In *Derivatives Markets*, $\Pr(Z < x)$ is written as $N(x)$.

The standard normal density function is

$$f_Z(x) = N'(x) = \frac{e^{-x^2/2}}{\sqrt{2\pi}} = \frac{e^{-x^2/2}}{\sqrt{2\times 3.14159}} = \frac{e^{-x^2/2}}{2.50663}, \qquad -\infty < x < \infty.$$

Let Y be a lognormal random variable. Assume that $\ln(Y)$ has mean m and standard deviation v. Then, the density function of Y is

$$f_Y(x) = \frac{1}{xv\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{\ln(x)-m}{v}\right)^2\right], \qquad x > 0.$$

The distribution function of Y is

$$F_Y(x) = N\left(\frac{\ln(x)-m}{v}\right), \qquad x > 0.$$

Also,

$$\mathrm{E}[Y^k] = \exp\left(km + \frac{1}{2}k^2v^2\right),$$

which is the same as the moment-generating function of the random variable $\ln(Y)$ evaluated at the value k.

FORMULAS FOR OPTION GREEKS:

Delta (Δ)

Call: $e^{-\delta(T-t)}N(d_1)$,

Put: $-e^{-\delta(T-t)}N(-d_1)$

Gamma (Γ)

Call and Put: $\frac{e^{-\delta(T-t)}N'(d_1)}{S\sigma\sqrt{T-t}}$

Theta (θ)

Call: $\delta Se^{-\delta(T-t)}N(d_1) - rKe^{-r(T-t)}N(d_2) - \frac{Ke^{-r(T-t)}N'(d_2)\sigma}{2\sqrt{T-t}}$,

Put: Call Theta + $rKe^{-r(T-t)} - \delta Se^{-\delta(T-t)}$

Vega

Call and Put: $Se^{-\delta(T-t)}N'(d_1)\sqrt{T-t}$

Rho (ρ)

Call: $(T-t)Ke^{-r(T-t)}N(d_2)$,

Put: $-(T-t)Ke^{-r(T-t)}N(-d_2)$

Psi (ψ)

Call: $-(T-t)Se^{-\delta(T-t)}N(d_1)$,

Put: $(T-t)Se^{-\delta(T-t)}N(-d_1)$