Formula Sheet Used on Exam ALTAM

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Interest Functions

$$\alpha(m)=\frac{id}{i^{(m)}d^{(m)}} \quad \text{and} \quad \beta(m)=\frac{i-i^{(m)}}{i^{(m)}d^{(m)}}$$

Makeham's Law

$$\mu_x = A+Bc^x \quad \text{and} \quad {}_tp_x=\exp\left(-At-\frac{B}{\log c}c^x\left(c^t-1\right)\right)$$

Three-term Woolhouse's Formula in a single decrement context

$$\ddot{a}_x^{(m)} \approx \ddot{a}_x-\frac{m-1}{2m}-\frac{m^2-1}{12m^2}\left(\delta+\mu_x\right)$$

Three-term Woolhouse's Formula in a multiple state context

$$\ddot{a}_x^{(m)ii} \approx \bar{a}_x^{ii}+\frac{1}{2m}+\frac{\mu_x^{i\bullet}+\delta}{12m^2} \quad \text{where } \mu_x^{i\bullet}=\sum_{j\neq i}\mu_x^{ij}$$

$$\ddot{a}_x^{(m)ij} = \bar{a}_x^{ij}-\frac{\mu_x^{ij}}{12m^2} \quad i\neq j$$

Note that in the "three-term" equation for $\ddot{a}_x^{(m)ij}$, where $i\neq j$, the second term is equal to zero.

Black Scholes Put Option Value

$$p(t)=Ke^{-r(n-t)}\Phi\left(-d_2(t)\right)-S_t\Phi\left(-d_1(t)\right)$$

$$\text{where} \quad d_1(t)=\frac{\log\left(S_t/K\right)+\left(r+\sigma^2/2\right)\left(n-t\right)}{\sigma\sqrt{n-t}} \quad \text{and} \quad d_2(t)=d_1(t)-\sigma\sqrt{n-t}$$

GMMB Embedded Option Value

Assume management charges of m per year payable continuously and a GMMB of kP. Let F_t denote the fund value immediately after any expense deduction at $t\geq 0$.

$$p(t)=kPe^{-r(n-t)}\Phi\left(-d_2(t)\right)-F_t\,e^{-m(n-t)}\Phi\left(-d_1(t)\right) \quad \text{and} \quad \pi(t)={}_{n-t}p_{x+t}^{(\tau)}\,p(t)$$

$$\text{where} \quad d_1(t)=\frac{\log\left(F_te^{-m(n-t)}/kP\right)+\left(r+\sigma^2/2\right)\left(n-t\right)}{\sigma\sqrt{n-t}} \quad \text{and} \quad d_2(t)=d_1(t)-\sigma\sqrt{n-t}$$

Candidates are expected to use Excel to calculate Normal distribution probabilities.