

Chapter 4

Life Insurance and Endowments

Type of Coverage	Payable at Moment of Death	Payable at End of Year	Payable at End of Each (1/m)th of a Year
whole life	$\text{---} = \int v^t \cdot {}_t p_x \cdot \mu_{x+t} dt$	$\text{---} = \sum v^{k+1} \cdot {}_k p_x \cdot q_{x+k}$	$\text{---} = \sum v^{k+1/m} \cdot {}_{k/m} p_x \cdot {}_{1/m} q_{x+k/m}$
n-year term insurance	$\text{---} = \int v^t \cdot {}_t p_x \cdot \mu_{x+t} dt$	$\text{---} = \sum v^{k+1} \cdot {}_k p_x \cdot q_{x+k}$	$\text{---} = \sum v^{k+1/m} \cdot {}_{k/m} p_x \cdot {}_{1/m} q_{x+k/m}$
n-year pure endowment	$A_{x:n}^1 = {}_n E_x = \text{---} \leftarrow \text{express with } v \text{ and } p$		
n-year endowment insurance	$\text{---} = \bar{A}_{x:n}^1 + \text{---} = \bar{A}_{x:n}^1 + \text{---}$	$\text{---} = \text{---} + {}_n E_x$	$A_{x:n}^{(m)} = \text{---} + {}_n E_x$
u-year deferred n-year term	$\text{---} = \text{---} \cdot \bar{A}_{x+u:n}^1$	$\text{---} = \text{---} \cdot A_{x+u:n}^1$	$\text{---} = \text{---} \cdot A_{x+u:n}^{(m)}$
n-year deferred whole life	$\text{---} = \text{---} \cdot \bar{A}_{x+n} = v^n \cdot {}_n p_x \cdot \bar{A}_{x+n}$	$\text{---} = \text{---} \cdot A_{x+n} = v^n \cdot {}_n p_x \cdot A_{x+n}$	$\text{---} = \text{---} \cdot A_{x+n}^{(m)}$

Variances

Type of Coverage	Payable at Moment of Death	Payable at End of Year	Payable at End of Each (1/m)th of a Year
whole life			
n-year term insurance			
n-year pure endowment			
n-year endowment insurance			
n-year deferred whole life			

Relationships

Payable at Moment of Death	Payable at End of Year
$\bar{A}_x = \text{---} + {}_n \bar{A}_x = \bar{A}_{x:n}^1 + {}_n E_x \cdot \text{---} = \text{---} + v^n \cdot {}_n p_x \cdot \bar{A}_{x+n}$	$A_x = A_{x:n}^1 + \text{---} = A_{x:n}^1 + {}_n E_x \cdot \text{---} = A_{x:n}^1 + v^n \cdot {}_n p_x \cdot \text{---}$

Payable at End of Year Only		
$A_x = v \cdot \text{---} + \text{---} \cdot A_{x+1}$	${}^2 A_x = \text{---}$	

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Assuming UDD

$$\bar{A}_x = i/\delta A_x ; \bar{A}_{x:n}^1 = i/\delta A_{x:n}^1 ; \bar{A}_{x:n} = i/\delta A_{x:n}^1 + {}_nE_x ; A_x^{(m)} = i/i^{(m)} A_x$$

Varying Death Benefit

General Formula – Payable at Moment of Death	$\int_0^\infty b_t \cdot v^t \cdot {}_t p_x \cdot \mu_{x+t} dt$
General Formula – Payable at End of Year of Death	$\sum_{k=0}^\infty b_{k+1} \cdot v^{k+1} \cdot {}_k p_x \cdot q_{x+k}$
$(\bar{IA})_x$	$\int_0^\infty t \cdot v^t \cdot {}_t p_x \cdot \mu_{x+t} dt$
$(\bar{IA})_{x:n}^1$	$\int_0^n t \cdot v^t \cdot {}_t p_x \cdot \mu_{x+t} dt$
$(IA)_x$	$\sum_{k=0}^\infty (k+1) \cdot v^{k+1} \cdot {}_k p_x \cdot q_{x+k}$
$(IA)_{x:n}^1$	$\sum_{k=0}^{n-1} (k+1) \cdot v^{k+1} \cdot {}_k p_x \cdot q_{x+k}$