FM-1

Q1] $i^{(4)} = 8\%$

i)

ii) $(1+i)^{-1} = \left(1 - \frac{0.08}{4}\right)^{4}$

$1+i = \frac{1}{(0.98)^4} = 1.084166$

$i = 0.084166$

iii) $d^{(12)} = ?$

$1-d = \left(1 - \frac{d^{(12)}}{12}\right)^{12}$

$(1-d)^{1/12} = 1 - \frac{d^{(12)}}{12}$

$\Rightarrow 1 - \frac{d^{(12)}}{12} = 0.993288$

$0.077632 = \frac{d^{(12)}}{12}$

$d^{(12)} = 0.931584$

Q2] i) $PV(10) = e^{-\int_0^{10} \delta(t)\,dt} = e^{-\left\{0.004\left[\frac{t^2}{2}\right]_0^{10} + 0.0002\left[\frac{t^3}{3}\right]_0^{10}\right\}}$

$= 0.2 + 0.2/3$

$\cancel{0.4} = e^{-0.26667}$

Present Value $= CV(t)$

$= 1000\left(e^{-0.26667}\right)$

$= 765.926$

ii)

ii) $e^{\delta t} = 1+i$ OR

~~AV(10) Accumulated Value~~ $\cancel{= C(1+i)^{10} = 1000}$.

$\cancel{i = (1000)^{1/10} - 1 = 1.99526 - 1}$

$\cancel{= 0.99526}$

Present Value $= Cv^{10} = 765.926$

$\Rightarrow \quad v^{10} = 0.765926$

$(1+i)^{10} = \dfrac{1}{0.765926}$

$1+i = \dfrac{1}{(0.765926)^{1/10}}$

$\Rightarrow \boxed{i = 2.70257\%}$

Q3] i) By reasoning, the time horizons of d and i are different i.e d is calculated in the advance of the year, while i is calculated at the end of the year. For finding the relation between d and i, we discount i by a year (v¹) to bring its value equal to d. Thus:-

$\boxed{d = iv}$ is justified.

ii) $i^{(2)} = ?$

a) $d = 2.25\%$

$i = \dfrac{d}{1-d} = \dfrac{0.0225}{0.9775} = 0.023017$

$i^{(12)} = \{(1+i)^{1/2} - 1\}12.$

$i^{(12)} = 0.13749$

$d^{(12)} = \dfrac{i}{1+i} =$

ii) $\frac{d^{(4)}}{4} = 0.0225$

a) $1-d = \cancel{1-0.22}\ (1-0.0225)^4 = 0.9129$

$\boxed{d = 0.0870}$

b) $\frac{d^{(2)}}{2} = \left[1 - \left\{(1-d)^{1/2}\right\}\right]$

$= \left[1 - (0.9129)^{1/2}\right]$

$\frac{d^{(2)}}{2} = 0.04454$

$\boxed{d^{(2)} = 0.089083}$

b) i

c) $\cancel{i = 0.05}$

$\cancel{i = \frac{d}{1-d} \Rightarrow d = \frac{i}{1+i} = \frac{0.05}{1.05} = 0.047619}$

$\cancel{\boxed{d = 4.7619\%}}$ [Done after 04]

04) i) Repeat

ii) $i = 0.08$, $d = 0.07407$

a) $d^{(12)} = \left[1 - \{1-d\}^{1/12}\right]12$

$= \left[1 - 0.993607\right]12$

$= 0.076714$

b) $i^{(365)} = 365\left[\{1+0.08\}^{1/365} - 1\right]$

$= 0.07696$

iii) $\delta = \ln(1+i)$
$= \ln(1.08)$
$= 0.076961$

iv) $i^{1/2}$

$$i^{1/2} = \frac{1}{2}\left[(1+0.08)^{1/1/2} - 1\right] = \frac{1}{2}\left[(1.08)^2 - 1\right]$$
$$= \underline{0.0832}$$

Q3] c) $i = 0.05$

Q5] i) $d^{(4)} = 0.06$

a) $i^{(2)} = ?$

$$d = 1 - \left\{1 - \frac{d^{(4)}}{4}\right\}^4$$

$$d = 1 - \left\{1 - \frac{0.06}{4}\right\}^4 = 0.058663$$

$$i = \frac{d}{1-d} \Rightarrow d = \frac{i}{1+i}$$

$\Rightarrow i = 0.003441$

$$i^{(2)} = \left[(1+i)^{1/2} - 1\right] 12 = \underline{0.061377}$$

b) $d^{(4)} = 0.06$

$d^{(12)} = ?$

$d = 1 - \left(1 - \frac{d^{(4)}}{4}\right)^4$

$1 - \left(1 - \frac{d^{(12)}}{12}\right)^{12} = 1 - \left(1 - \frac{d^{(4)}}{4}\right)^4$

$\left(1 - \frac{d^{(12)}}{12}\right)^{12} = 0.941336$

$d^{(12)} = 0.060302$

ii) $i = \frac{20,000}{2,00,000} \times 100 = \underline{10\%}$

$\frac{i^{(365)}}{365} = (1+i)^{1/365} - 1 = 0.0002611$

If we compound this daily effective interest rate for 3 Months 2 Days i.e 92 days, then

$A(92) = (1.0002611)^{92} = 1.024314$

~~Interest~~ Obtained Amt $= CA(92)$
$= \underline{\underline{2,04,862.855}}$

06] i) 0 — ½ — 1

Let the cost of the toy be 100, then:-

$75 = 70 V^*$ where $V^* \Rightarrow v$ for 6 months.

$75 = 70(1 - d^{(2)})$

$\frac{75}{70} = 1 - \left[2\left\{1 - (1-d)^{1/2}\right\}\right]$

$d^{(2)}$

April-May-June-July

100
2%
100 × 0.02 → $\boxed{2}$

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Q7) ~~$\frac{6000}{20,000} = \left(\frac{i^{(12)}}{12}\right)^{17}$~~

~~$i^{(12)} = 0.9316277$~~

~~$i = \left(1 + \frac{0.9316277}{12}\right)^{12} - 1$~~

~~$=$~~

i) ~~$20,000\left(1 + \frac{i^{4}}{4}\right) = 26,000$~~

~~$\left(1 + \frac{i^{4}}{4}\right) = \frac{26000}{20000} = \frac{26}{20}$~~

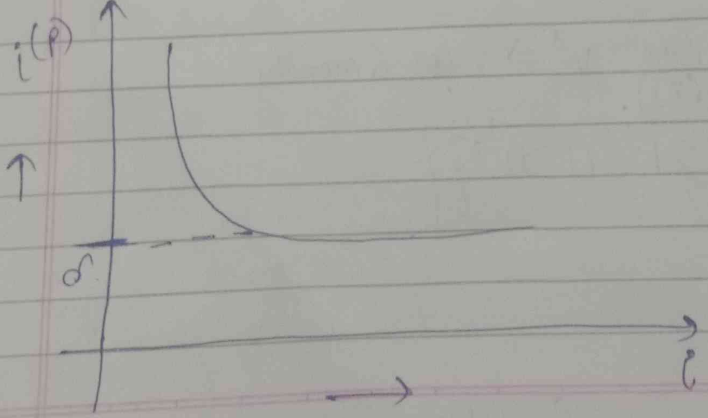
Q8] As the Relation between i and $i^{(p)}$ is

$$1 + i = \left(1 + \frac{i^{(p)}}{p}\right)^{p}$$

As $p \to \infty$, $i^{(p)} \to \delta$, where δ is defined as the force of interest. Thus, in this problem:-

$\delta = \ln(1.08) = 7.696\%$

The graph between $i^{(p)}$ and i, where δ is obtained is:-



Q9

Q9 i) Repeat

ii) $i^{(2)} = 0.0775$

$$i = \left(1 + \frac{i^{(2)}}{2}\right)^2 - 1$$

$$= \left(1 + \frac{0.775}{2}\right)^2 - 1 = 1.079002 - 1$$
$$= 0.079002$$

$$\delta = \ln(1+i)$$
$$= \ln(1.079)$$
$$= \underline{0.076036}.$$

$$d^{(12)} = 12\left[1 - v^{1/12}\right] = 12\left[1 - \left(\frac{1}{1.079002}\right)^{1/12}\right]$$
$$= 0.075796.$$

$$i^{(1/2)} = \frac{1}{2}\left[(1+i)^2 - 1\right] = \frac{1}{2}\left[(1.079)^2 - 1\right]$$
$$= 0.082122$$

Q10 i) $v(t) = e^{-\int_0^t \delta(t)\,dt}$

Hence

$$\delta(t)\,dt = \begin{cases} 0.08, \\ 0.06 \\ 0.04 \end{cases}$$

$$\int_0^t \delta(t)\,dt = \begin{cases} 0.08t \\ 0.06t + 0.01 \\ 0.3 + 0.04t \end{cases}$$

$$v(t) = \begin{cases} e^{-0.08t} \\ e^{-0.06t - 0.01} \\ e^{-0.3 - 0.04t} \end{cases}$$

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Q11] a) Amt required $= 50000\left(1 - \frac{9}{12} \times 0.18\right)$.

$= 43,250$.

b) i) $(1+i) = e^{\delta} = 1.0618$

$\Rightarrow i = 0.0618$.

$d = \frac{i}{1+i} = \frac{0.0618}{1.0618} = 0.9418$.

ii) $v = 1-d = \left(1 - \frac{d^{(4)}}{4}\right)^4 = 0.9413$.

$i = v^{-1} = \underline{0.0624}$

$i^{(12)} = 12\left[(1+i)^{1/12} - 1\right] = \underline{0.0607}$

c) The order is determined based on when the interest is paid ~~so~~, for example d corresponds to interest paid immediately which requires a smaller payment amount. Thus:-

$d < \delta < i^{(p)} < i$

d) With 1 unit of initial capital, d is the interest payable at the beginning of the year. Here, i is the interest payable at the end of year, while d must be equal to the present value at the ~~sta~~ outset.

i.e

$\boxed{d = iv}$.

Q9] i) Repeat.

ii) $i^{(2)} = 0.0775$

$$i = \left(1 + \frac{i^{(2)}}{2}\right)^2 - 1$$

$$= \left(\frac{1+0.775}{2}\right)^2 - 1 = 1.079002 - 1$$

$$= 0.079002$$

$$\delta = \ln(1+i)$$

$$= \ln(1.079)$$

$$= \underline{\underline{0.076036}}.$$

$$d^{(12)} = 12\left[1 - v^{1/12}\right] = 12\left[1 - \left(\frac{1}{1.079002}\right)^{1/12}\right]$$

$$= \underline{0.075796}.$$

$$i^{(1/2)} = \frac{1}{2}\left[(1+i)^2 - 1\right] = \frac{1}{2}\left[(1.079)^2 - 1\right]$$

$$= 0.082122$$

Q10] i) $v(t) = e^{-\int_0^t \delta(t)\,dt}$

Hence

$$\delta(t)\,dt = \begin{cases} 0.08 \\ 0.06 \\ 0.04 \end{cases}$$

$$\int_0^t \delta(t)\,dt = \begin{cases} 0.08t \\ 0.06t + 0.01 \\ 0.3 + 0.04t \end{cases}$$

$$v(t) = \begin{cases} e^{-0.08t} \\ e^{-0.06t - 0.01} \\ e^{-0.3 - 0.04t} \end{cases}$$

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