Marks : 40	SYJC March' 19 Subject : MATHS – II Insurance & Annuity / Demography	Duration : 1.5 Hours

Q.1. Attempt any Two : (2 marks each) : **(06)**

(1) Property value = ₹ 500000

Policy value = $\frac{4}{5}$ x 5,00,000

= ₹ 4,00,000

Rate of Premium = 5%

Amount of premium = ₹ 4,00,000 $\times \frac{5}{100}$

Premium amount is ₹ 20,000

Commission at 3% is 20,000 $\times \frac{3}{100}$

= ₹ 600.

(2) Value of the car is ₹ 1,80,000.

Insured Value = ₹ 1,50,000

Damage = ₹ 80,000

Claim = $\frac{\text{Insured value}}{\text{Property value}} \times \text{loss}$

= $\frac{150000}{180000} \times 80{,}000$

= ₹ 66,667

$\therefore$ Compensation of ₹ 66,667 can be claimed under the policy.

(3) Given : A = ₹ 2,00,000

r = 10% p.a. n = 4 years

$\therefore \quad i = \frac{r}{100} = \frac{10}{100} = 0.10$

To, find C

$A = \frac{C}{i}[(1 + i)^n - 1]$

$\therefore \quad 2{,}00{,}000 = \frac{C}{0.1}[(1 + 0.1)^4 - 1]$

$\therefore \quad 2{,}00{,}000 = \frac{C}{0.1}[(1.1)^4 - 1]$

$\therefore \quad 2{,}00{,}000 = \frac{C}{0.1}[1.4641 - 1]$

$\therefore \quad 2{,}00{,}000 = \frac{C}{0.1}(0.4641)$

$\therefore \quad C = \frac{200000 \times 0.1}{0.4641}$

$\therefore \quad C = \frac{20000}{0.4641} = 43094.16$

∴ Mr. Rana should invest ₹ 43094.16 at the end of each year for 4 years to get ₹ 2,00,000 at the end of 4 years.

(4) Given A = ₹ 20,500
C = ₹ 10,000, n = 2 year
To find r
Using accumulated value A

$A = \frac{C}{i}[(1 + i)^n - 1]$

$\therefore\ 20,500 = \frac{10000}{i}[(1 + i)^2 - 1]$

$\therefore\ \frac{20500}{10000} = \frac{1+2i+i^2-1}{i}$

$\therefore\ 2.05 = \frac{2i+i^2}{i}$

$\therefore\ 2.05 = 2 + i$

$\therefore\ i = 2.05 - 2$

$\therefore\ i = 0.05$

$\therefore\ i = \frac{r}{100}$

$\therefore\ 0.05 = \frac{r}{100}$

$\therefore\ r = 5$

∴ rate of interest is 5% p.a.

Q.2. Attempt any Four : (3 marks each) : **(12)**

(1) Given C = ₹ 1,000, r = 10% p.a.

n = 3 years $i = \frac{r}{100} = \frac{10}{100} = 0.1$

Using the formula for accumulated value A' of an annuity, due we get

$A' = \frac{C(1+i)}{i}[(1 + i)^n - 1]$

$\therefore\ A' = \frac{1000(1+0.1)}{0.1}[(1 + 0.1)^3 - 1]$

$\therefore\ A' = \frac{1000(1.1)}{0.1}[1.331 - 1]$

$= 11000\ (0.331)$

$= 3641$

∴ Accumulated value is ₹ 3641

(2) Property Value = ₹ 1,00,000
Policy Value = ₹ 70,000
Rate of premium = 0.4%

∴ Premium = 0.4% of policy value

$= 70,000 \times \frac{0.4}{100}$

= ₹ 280

∴ The total premium is = ₹ 280

Now claim = loss x $\frac{\text{Policy value}}{\text{property value}}$

$= 60,000 \times \frac{70,000}{1,00,000}$

$= ₹\ 42,000$

Total value of the cargo $= ₹\ 1,00,000$

Value of the cargo completely destroyed $= ₹\ 60,000$

$\therefore$ Remaining cargo $= ₹\ 40,000$

Loss on remaining value of the cargo

= 40% of the remaining value of the cargo

$= \frac{40}{100} \times 40,000$

$= ₹\ 16,000$

$\therefore$ Total loss $= 60,000 + 16,000$

$= ₹\ 76,000$

$\therefore$ Claim = loss $\times \frac{\text{Policy value}}{\text{property value}}$

$= 76,000 \times \frac{70,000}{1,00,000}$

$= ₹\ 53,200$

(3) Loss = ₹ 1,20,000.

$\therefore$ Claim = loss $\times \frac{\text{Policy value}}{\text{property value}}$

Claim from company X $= 1,20,000 \text{ X } \frac{60,000}{2,00,000}$

$= ₹\ 36,000$

Claim from company Y $= 1,20,000 \text{ X } \frac{40,000}{2,00,000}$

$= ₹\ 24,000$

Claim from company Z $= 1,20,000 \text{ X } \frac{50,000}{2,00,000}$

$= ₹\ 30,000.$

(4) Policy Value $= ₹\ 70,000$

Rate of premium = ₹ 56.50 per thousand per annum

$\therefore$ Amount of premium $= \frac{56.50}{1000} \times 70,000$

$= ₹\ 3,955.$

He pays premium for 15 year.

$\therefore$ Total premium paid $= 3,955 \text{ X } 15$

$= 59,325$

Rate of bonus is ₹ 6 per thousand per annum of the policy value.

$\therefore$ On 70,000 policy value

bonus for 1 years $= 6 \times 70$

$= ₹\ 420$

$\therefore$ Bonus for 15 years $= 420 \times 15$

$= ₹\ 6,300$

$\therefore$ When policy matures,

The person gets ₹ $= 70,000 + 6,300 = ₹\ 76,300$

$\therefore$ Benefit $= 76,300 - 59,325$

= ₹ 16,975

(5) Since ₹ 10,000 is deposited at the end of every six months.
∴ It is an immediate annuity.
C = ₹ 10,000
Rate of interest is 10% p.a.
∴ for six months it is 5%.
∴ r = 5%
∴ $i = \frac{r}{100} = \frac{5}{100} = 0.05$
∴ No. of half years of 2 years = 2 x 2 = 4
∴ n = 4
Using formula accumulate value A
$A = \frac{C}{i}[(1 + i)^n - 1]$
$\therefore A = \frac{10000}{0.05}[(1 + 0.05)^4 - 1]$
∴ = 2,00,000 [1.2155 -1]
= 2,00,000 [0.2155]
= 43,100.
∴ Accumulated amount at the end of 2 years is ₹ 43,100.

Q.3. Attempt any One : (4 marks each) : **(04)**

(1) Policy value = ₹ 100000.
Period of policy = 20 years.
Rate of premium = ₹ 76 per thousand
∴ amount of premium = $\frac{76}{1000} \times 100000$
= ₹ 7600
He pays for 10 annual premium
∴ total premium paid = ₹ (10 ×7600)
= ₹ 76000
Rate of bonus = ₹ 7 per thousand p.a. of the policy value.
∴ on policy of ₹ 100000 bonus for one year
$= \frac{7}{1000} \times 100000$ = ₹ 700
∴ bonus for 10 years = ₹ 10 × 700
= ₹ 7000
He dies after paying 10 annual premiums.
∴ his nominee will get amount
= Policy value + Bonus earned
= ₹ (100000 + 7000)
= ₹ 107000.

(2) The value of 3000 bedsheets = ₹ 480000.
Insured value = $₹ \left(480000 \times \frac{3}{7}\right)$
$= ₹ \frac{1440000}{7}$

Cost of one bedsheet = ₹ $\frac{480000}{3000}$ = ₹ 160

Let x bedsheets be damaged in the rainy season.

Cost of x bedsheets = ₹ 160x

$\therefore$ the value of damaged bedsheets = $160x \times \frac{40}{100}$ = ₹ 64x

$\therefore$ loss = ₹ 64x for x damaged bedsheets.

Now, claim = $\frac{\text{Insured value}}{\text{Total value}} \times \text{Loss}$

$\therefore \quad 24000 = \frac{\frac{1440000}{7}}{480000} \times 64x$

$\therefore \quad 24000 = \frac{1440000 \times 64x}{7 \times 480000}$

$\therefore \quad 24000 = \frac{3 \times 64x}{7}$

$\therefore \quad 24000 \times 7 = 192x$

$\therefore \quad x = \frac{24000 \times 7}{192}$

$\therefore \quad x = 875$

Hence, the number of damaged bedsheets is 875.

(3) Here, C = ₹ 10000, A = ₹ 20500, n = 2, r = ?

Now, $A = \frac{C}{i}[(1 + i)^n - 1]$

$\therefore \quad 20500 = \frac{10000}{i}[(1 + i)^2 - 1]$

$\therefore \quad \frac{20500}{10000} = \frac{(1+i)^2 - 1}{i}$

$\therefore \quad 2.05 = \frac{1 + 2i + i^2 - 1}{i}$

$\therefore \quad 2.05 = \frac{i(2 + i)}{i}$

$\therefore \quad 2.05 = 2 + i$

$\therefore \quad 2.05 - 2 = i$

$\therefore \quad i = 0.05$

Now, $i = \frac{r}{100}$

$\therefore \quad 0.05 = \frac{r}{100}$

$\therefore \quad r = 0.05 \times 100$

$\therefore \quad r = 5\%$

Hence, the rate of interest is 5%.

Q.4. Attempt Any Two of the following : (2 marks each) **(04)**

1. $CDR = \frac{\sum D_i}{\sum P_i} \times 1{,}000$

For population A

$\sum D_1 = 170 + 115 + 490 + 630$

$= 1405$

$\sum P_1 = 13 + 20 + 52 + 22$

$= 107$ (in thousands)

$\therefore$ CDR for population A denoted by CDR_A is

$CDR_A = \frac{\sum D_i}{\sum P_i} \times 1{,}000$

$= \frac{1405}{107000} \times 1{,}000$

$= 13.13$ per thousand.

For population B :

$\sum D_i = 510 + 130 + 570 + 680$

$= 1890$

$\sum P_i = 15 + 35 + 54 + 23$

$= 127$ (in thousands)

$\therefore$ CDR for population B denoted by CDR_B is,

$CDR_B = \frac{\sum D_i}{\sum P_i} \times 1{,}000$

$= \frac{1809}{127000} \times 1{,}000$

$= 14.88$ per thousand.

Observe that population A is more healthy than population B as $CDR_A < CDR_B$.

2. $\sum D_i = 1250 + 1000 + 1750 + 1680$

$= 5680$

$\sum P_i = 25 + x + 28 + 15$

$= 68 + x$ (in thousands)

$CDR = 56.8$

$CDR = \frac{\sum D_i}{\sum P_i} \times 1000$

$56.8 = \frac{5680}{(68 + x)1000} \times 1000$

$3862.4 + 56.8x = 5680$

$56.8x = 5680 - 3862 - 4$

$56.8x = 1817.6$

$x = \frac{1817.6}{56.8}$

$x = 32$

3.

Age – Group (years)	Population (in' 000)	No of Deaths	SDR $= \frac{D}{P}$ x 1000
0 – 30	20	32	$\frac{32}{20000}$ x 1000 = 1.6
30 – 60	30	60	$\frac{60}{30000}$ x 1000 = 2
60 – 80	40	88	$\frac{88}{40000}$ x 1000 = 2.2
Above 80	10	60	$\frac{60}{10000}$ x 1000 = 6

4. l_0, = 100, $q_0 = 0.10$, $q_1 = \frac{1}{9}$, $p_2 = \frac{15}{16}$

We have, $q_x = \frac{d_x}{l_x}$

$\therefore q_0 = \frac{d_0}{l_0}$

$\therefore 0.10 = \frac{d_0}{100}$

$\therefore d_0 = 10$

Now, $d_x =, l_x, - l_{x+1}$

$\therefore d_0 = l_0 - l_1$

$\therefore 10 = 100 - l_1$

$\therefore l_1 = 100 - 10 = 90$

$q_1 = \frac{d_1}{l_1}$

$\therefore \frac{1}{9} = \frac{d_1}{90}$

$\therefore d_1 = 10$

Now, $d_1 =, l_1, - l_2$

$\therefore 10 = 90 - l_2$

$\therefore l_2 = 90 - 10 = 80$

Q.5. Attempt Any four of the following : (3 marks each) **(12)**

1. $l_{92} = 59$, $L_{92} = 46$, $p_{92} = ?$

$L_x = \frac{l_x + l_{x+1}}{2}$

$\therefore L_{92} = \frac{l_{92} + l_{93}}{2}$

$\therefore 46 = \frac{59 + l_{93}}{2}$

$\therefore (2 \times 46) - 59 = l_{93}$

$\therefore 92 - 59 = l_{93}$

$\therefore l_{93} = 33$

$p_x = \frac{l_{x+1}}{l_x}$

$\therefore P_{92} = \frac{l_{93}}{l_{92}}$ $\therefore P_{92} = \frac{33}{59}$

$\therefore P_{92} = 0.559322$

2.

Age group (years)	District A		District B	
	No. of persons	No. of Deaths	No. of persons	No. of Deaths
	(in '000)		(in '000)	
0 – 15	1	20	2	50
15 – 55	3	30	7	70
60 & above	2	40	1	25
Total	$\sum P_i$	$\sum D_i$	$\sum P_i$	$\sum D_i$
	= 6	= 90	= 10	= 145

District A : $CDR_A = \frac{\sum D_i}{\sum P_i} = \frac{90}{6000} \times 1000$

$\therefore$ CDR_A = 15 per thousand

District B :

$$CDR_B = \frac{\sum D_i}{\sum P_i} = \frac{145}{100} \times 1000$$

$\therefore$ CDR_B = 14.5 per thousand

Comparison : Since $CDR_B < CDR_A$, the population of District B is more healthier.

3.

Age group (years)	Town I		Town II	
	P_i	D_i	P_i	D_i
0 – 10	1,500	45	6,000	150
10 – 25	5,000	30	6,000	40
25 – 45	3,000	15	5,000	20
45 & above	500	22	3,000	54
Total	$\sum P_1$ = 1,000	$\sum D_1$ = 112	$\sum P_1$ = 20,000	$\sum D_1$ = 264

Town I :

$$CDR_I = \frac{\sum D_i}{\sum P_i} \times 1{,}000 = \frac{112}{10{,}000} \times 1{,}000$$

$\therefore$ CDR_I = 11.2 per thousand

Town II :

$$CDR_{II} = \frac{\sum D_i}{\sum P_i} \times 1{,}000 = \frac{264}{20{,}000} \times 1{,}000 = \frac{132}{10}$$

$\therefore$ CDR_{II} = 13.2 per thousand

Comment : $CDR_I < CDR_{II}$

4.

Age group (years)	Town A		Town B	
	Population	No. of Deaths	Population	No. of Deaths
	(in '000)		(in '000)	
0 – 5	25	550	20	440
5 – 15	40	280	30	210
15 - 35	60	720	40	480
Above 35	15	525	30	1050
Total	$\sum P_1$	$\sum D_1$	$\sum P_1$	$\sum D_1$
	= 140	= 2075	= 120	= 2180

Town A :

$$CDR_A = \frac{\sum D_i}{\sum P_i} = \frac{2075}{140000} x 1000$$

$\therefore$ CDR_A = 14.82 per thousand

Town B :

$$CDR_B = \frac{\sum D_i}{\sum P_i} = \frac{2180}{120000} x 1000$$

$\therefore$ CDR_B = 18.17

Comment : Since, $CDR_A < CDR_B$ the population of town A is more healthier than the population of town B.

5. l_{26} = 9046, l_{27} = 8898 and T_{26} = 36,000,

$$L_x = \frac{l_x + l_{x+1}}{2}$$

$$\therefore L_{26} = \frac{l_{26} + l_{27}}{2} = \frac{9046 + 8898}{2}$$

$$= \frac{17944}{2}$$

$\therefore$ L_{26} = 8972

$T_x = L_x = T_{x+1}$

$\therefore$ $T_{26} = L_{26} + T_{27}$

$\therefore$ $36,000 = 8972 + T_{27}$

$\therefore$ $T_{27} = 36,000 - 8972$

$\therefore$ $T_{27} = 27028$

$$e^0_x = \frac{T_x}{l_x}$$

$$\therefore e^0_{26} = \frac{T_{26}}{l_{26}} = \frac{36,000}{9,046}$$

$\therefore$ $e^0_{26} = 3,9796$

$L_{26} = 8972$, $T_{27} = 27028$, $e^0_{26} = 3,9796$

Q.6. Attempt Any One of the following: (4 marks each) **(04)**

1. $d_x = l_x = l_{x+1}$

$d_0 = l_0 - l_1$

= 1,000 – 940 = 60 etc.

$q_x = \frac{d_x}{l_x}$

$q_0 = \frac{d_0}{l_0}$

$= \frac{60}{1{,}000}$

= 0.06 etc.

$L_x = \frac{l_x + l_{x+1}}{2}$

$L_0 = \frac{l_0 + l_1}{2}$

$= \frac{1{,}000 + 940}{2}$

= 970, etc.

The complete life table for the parrots is given below:

Age x	l_x	$D_x = l_x - l_{x+1}$	$q_x = \frac{d_x}{l_x}$	$P_x = 1-q$	$L_x = \frac{l_x + l_{x+1}}{2}$	$T_x =$	$e_x^0 = \frac{T_x}{l_x}$
0	1,000	60	0.0600	0.94	970.0	2835.	2.8350
1	940	160	0.1702	0.8298	860.0	1865.0	1.9840
2	780	190	0.2435	0.7565	685.0	1005.0	1.2885
3	590	565	0.9576	0.0424	307.5	320.0	0.5424
4	25	25	1.0000	0	12.5	12.5	0.5000
5	0	-		-	-	-	-

2.

x	0	1	2	3	4	5
d_x	10	10	20	30	30	-
q_x	0.10	0.11	0.25	0.50	1.0	-
p_x	0.90	0.89	0.75	0.50	0	-
L_x	95	85	70	45	15	-

3.

x	L_x	d_x	q_x	p_x	L_x
0	4,000	1,000	0.25	0.75	3,500
1	3,000	2,000	0.66	0.34	2,000
2	1,000	800	0.80	0.20	600
3	200	160	0.80	0.20	120
4	40	40	1.00	0	20
5	0	-	-	-	-

❑❑❑