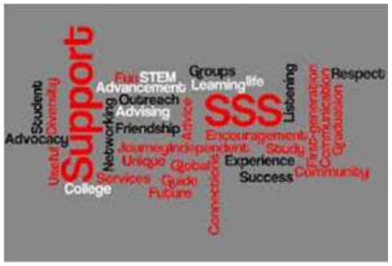
# IAI Connect 2014

Presentation by Subhendu Bal,

20th August 2014

# Institute of Actuaries of India

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SUBHENDU BAL

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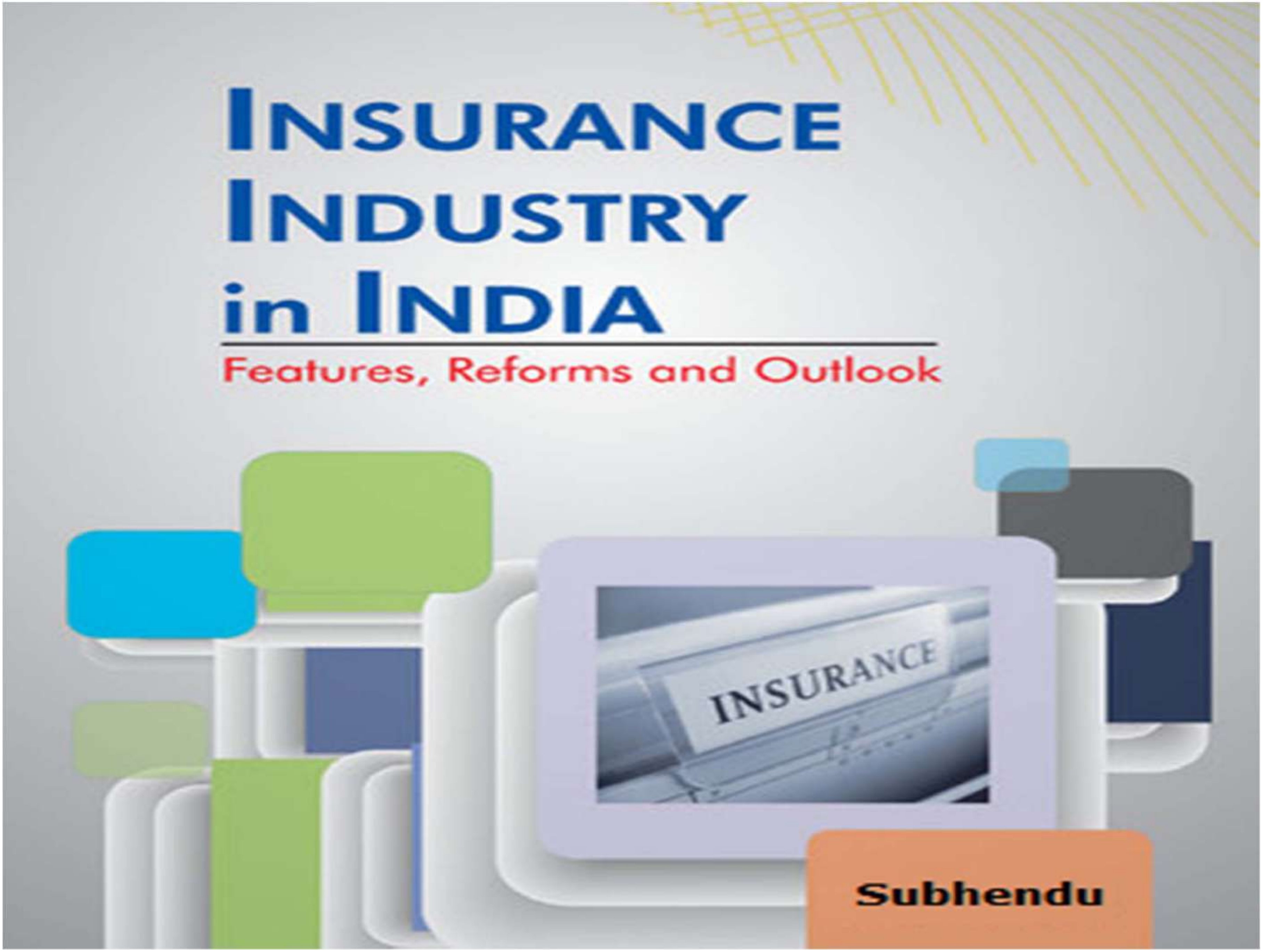
# Agenda

- ➢ Insurance Industry
- ➢ The Actuarial Profession
- ➢ Examination System
- ➢ Actuarial Papers - CT3
- ➢ Conclusion


INSURANCE
INDUSTRY
in INDIA
Features, Reforms and Outlook
INSURANCE
Subhendu

# Insurance Industry

- **Insurance in India** refers to the market for insurance in India which covers both the public and private sector organizations

- It is listed in the Constitution of India in the Seventh Schedule meaning it can only be legislated by the Central Government

- The insurance sector has gone through a number of phases by allowing private companies to solicit insurance and also allowing foreign direct investment

# Insurance Industry .. (Contd)

- Insurance in its current form has its history dating back until 1818, when *Oriental Life Insurance Company* was started by Anita Bhavsar in Kolkata to cater to the needs of European community

- The pre-independence era in India saw discrimination between the lives of foreigners (English) and Indians with higher premiums being charged for the latter

- In 1870, *Bombay Mutual Life Assurance Society* became the first Indian insurer

- In the year 1912, the Life Insurance Companies Act and the Provident Fund Act were passed to regulate the insurance business

# Insurance Industry .. (Contd)

- The Life Insurance Companies Act, 1912 made it necessary that the premium-rate tables and periodical valuations of companies should be certified by an Actuary

- The Government of India issued an Ordinance on 19 January 1956 nationalising the Life Insurance sector and Life Insurance Corporation came into existence in the same year

- The Life Insurance Corporation (LIC) absorbed 154 Indian, 16 non-Indian insurers as also 75 provident societies—245 Indian and foreign insurers in all

- Life insurance in India was nationalized on 19 January 1956, through the Life Insurance Corporation Act.

# Insurance Industry .. (Contd)

- In 1972 with the General Insurance Business (Nationalisation) Act was passed by the Indian Parliament, and consequently, General Insurance business was nationalized with effect from 1 January 1973

- The General Insurance Corporation of India was incorporated as a company in 1971 and it commence business on 1 January 1973

- 107 insurers were amalgamated and grouped into four companies, namely National Insurance Company Ltd., the New India Assurance Company Ltd., the Oriental Insurance Company Ltd and the United India Insurance Company Ltd. are the four subsidiaries of The General Insurance Corporation of India

# Insurance Industry .. (Contd)

- The insurance sector went through a full circle of phases from being unregulated to completely regulated and then currently being partly deregulated. It is governed by a number of acts.

- The Insurance Act of 1938 was the first legislation governing all forms of insurance to provide strict state control over insurance business

- Until 1999, there were no private insurance companies in India

- In 1993, the Government of India appointed RN Malhotra Committee to lay down a road map for privatisation of the life insurance sector

# Insurance Industry .. (Contd)

- The government then introduced the Insurance Regulatory and Development Authority Act in 1999, thereby de-regulating the insurance sector and allowing private companies

- The primary regulator for insurance in India is the Insurance Regulatory and Development Authority (IRDA) which was established in 1999 under the government legislation called the *Insurance Regulatory and Development Authority Act, 1999*

- Furthermore, foreign investment was also allowed and capped at 26% holding in the Indian insurance companies

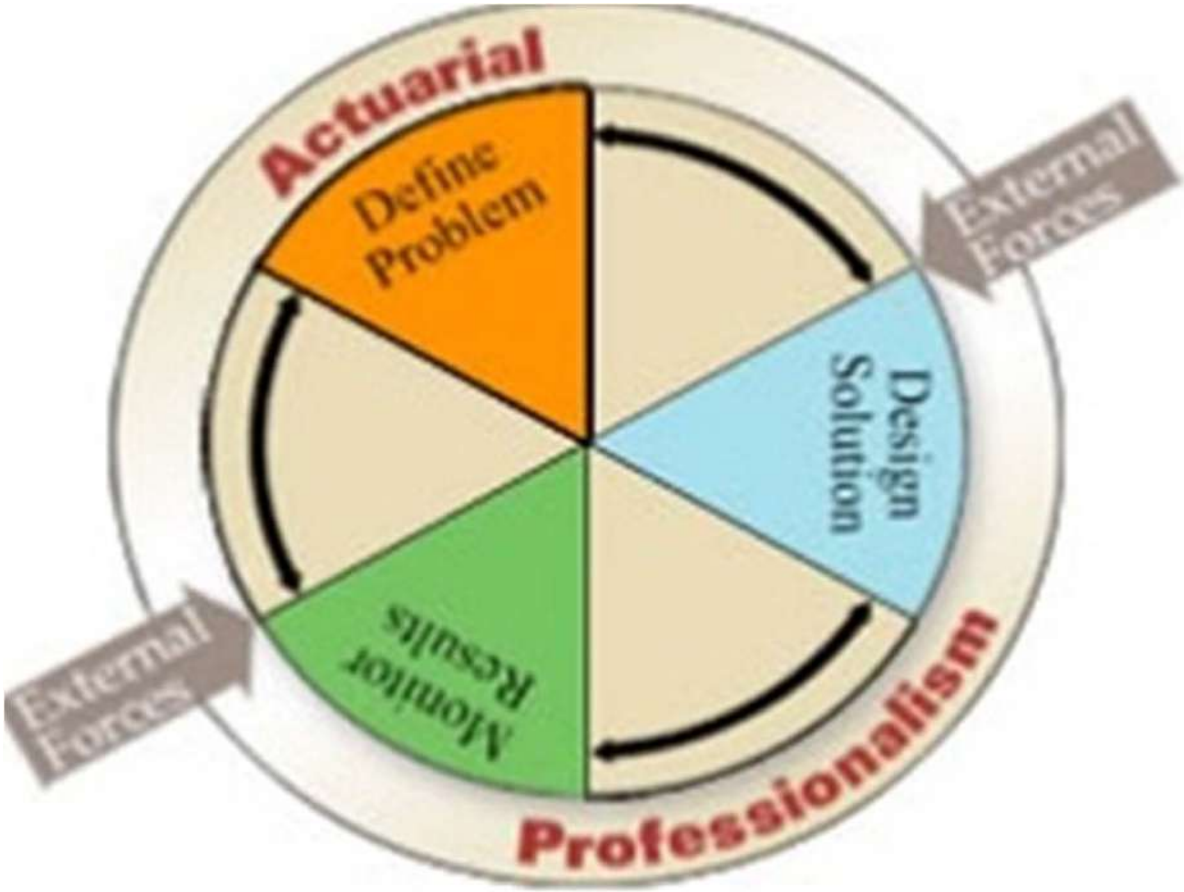
# Insurance Industry .. (Contd)

# Insurance Industry .. (Contd)

- As of today there are total 24 life insurance companies in India, 1 in Public sector and 23 in Private sector

- There 28 non-life insurers, The General Insurance Corporation of India, other general insurers, Health insurers along with 1 Agriculture and Export Credit insurer.

# Actuarial Profession




➡ **History** ➡ **Actuary** ➡ **Scope**

# Actuarial Profession - History

- The birth of the actuarial profession can be conveniently fixed as 1848, when the Institute of Actuaries, an organisation was set up in London

- Institute of Actuaries, started a system of examinations in 1850, only two years after the founding of the Institute

- The Faculty of Actuaries in Edinburgh followed in 1856. Victorian Great Britain provided a favorable environment for the development of professions

- In 1889, the American Society of Actuaries was founded with members in both Canada and the United States

# Actuarial Profession - History..(Contd)

- The Actuarial Society of America followed the lead of the Institute by starting an examination program in 1897

- The Association of Swiss Actuaries was founded in 1905

- The Casualty Actuarial Society was founded in the United States in 1914 and within a few months started an examination system

- The Actuarial Society of India (ASI) was established in September 1944

- Since 1979 the ASI has been a Full Member of International Actuarial Association and is actively involved in its affairs

# Actuarial Profession - History..(Contd)

- In 1982, the ASI was registered under Registration of Literary, Scientific and Charitable Societies Act XXI of 1860 and also under Bombay Public started conducting examination leading to professional qualification of an actuary

- Till then the accreditation was based on Institute of Actuaries, London examinations

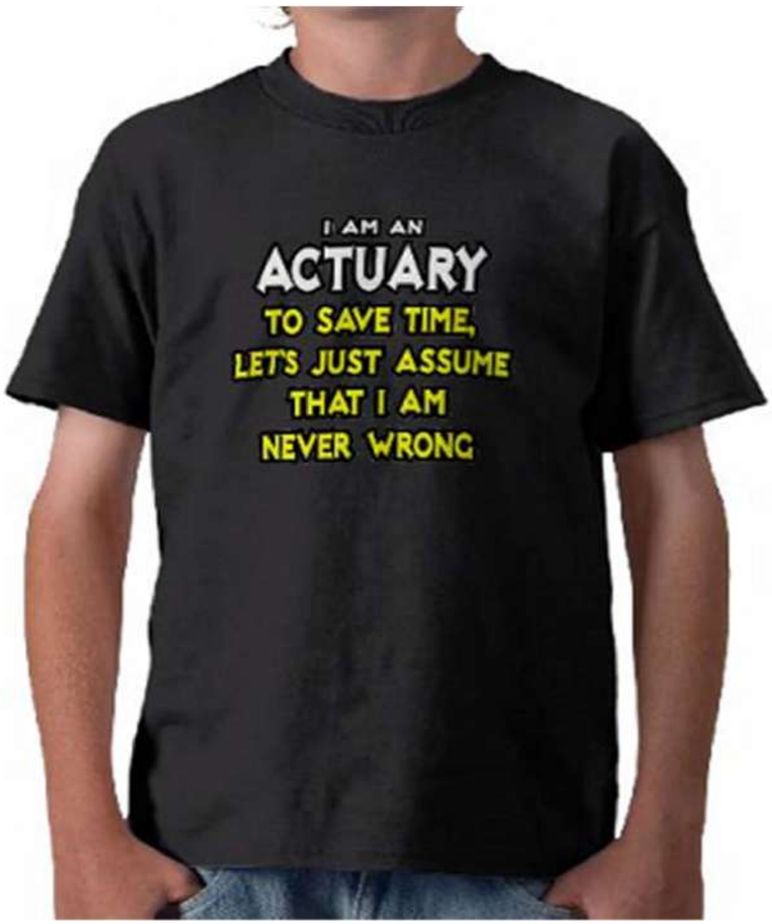
- The Government of India in the Ministry of Finance, Department of Economic Affairs , issued the notification dated 8th November 2006 to establish the actuarial profession under the provisions of the Actuaries Act

- On 10th November 2006 ASI was dissolved and IAI is a statutory body established under The Actuaries Act 2006 for regulation of profession of Actuaries in India

# Actuarial Profession - Actuary

# Actuarial Profession - Actuary

- What do you mean by an actuary?



# Actuarial Profession – Actuary..(Contd)

- An **actuary** is a business professional who deals with the financial impact of risk and uncertainty
- Actuaries mathematically evaluate the probability of events and quantify the contingent outcomes in order to minimize the impacts of financial losses associated with uncertain undesirable events
- “Actuary” means a person skilled in determining the present effects of future contingent events or
  - in finance modelling and risk analysis in different areas of insurance, or
  - calculating the value of life interests and insurance risks,
  - or designing and pricing of policies, working out the benefits recommending rates relating to insurance business, annuities, insurance and pension rates on the basis of empirically based tables and
  - includes a statistician engaged in such technology, taxation, employees’ benefits and such other risk management and investments and
  - who is a fellow member of the Institute.

# Actuarial Profession – Actuary..(Contd)

- What does actuaries do?

- Analyze financial and demographic events; apply financial and statistical theories to solve real business problems

- Actuarial Science helps in,
  - ✓ understanding the risk involved
  - ✓ Development of solution and
  - ✓ monitoring the experience for the better management of insurance operations
  - ✓ Simulate future financial scenarios with likelihood; take key optimal decisions based on that.

- Let us check this Clip 1.avi

# Actuarial Profession – Actuary ..(Contd)

- In India to run any life insurance business, an actuary (more specifically an Appointed Actuary) is mandated
- The duties and obligations along with the power are prescribed in the IRDA regulations
- Appointed Actuary has to fulfill several conditions to become an appointed actuary to a life insurance company
- In life insurance company actuary has to be an employee of the insurer, can not be a consultant

# Actuarial Profession – Actuary ..(Contd)

# Actuarial Profession - Scope

- The main areas where the actuary or any actuarial student can fit into are:
  - Life Insurance
  - General Insurance
  - Health Insurance
  - Employee Benefit Schemes, Pension Business
  - Investment – General and Derivatives
  - ALM and Risk Management

- Check the areas of scope in India Clip 2.avi

Examination

System

# Examination System

- The main objective of any examination system should be such that the candidate who clear the subject are expected to understands the concept of the subject
- One of the main objective of IAI is to be fairer to the candidates
- In actuarial examination there are more than one examiner to set the papers
- The examiners also prepare the indicative solution by themselves to check the applicability of marks and time required to answer them
- After setting the papers by the examiners the review examiner also check for the question papers
- The question papers also reviewed by the external examiners

# Examination System ..(Contd)

- The examiners, review examiner or external examiners take care of the following criteria at the minimum:
  - Questions are within syllabus
  - Questions are not too hard or too easy
  - Questions are of knowledge based, application based or higher skill based
  - Questions will be differently weighted for different series, CT, CA, ST or SA
  - Questions can be answered by a well prepared candidate within time
  - Questions are not straightway pickup from any material which are available in public domain
  - The mark distribution of the questions would be as per the answer expected

# Examination System ..(Contd)

- At least two examiners or markers do check the copies
- The pass mark and the result declaration process are very objective criteria based
- The markers and/or examiners are always kept out of reach about the identity of any candidates
- All so called border line cases are examined several times by three examiners
- The administration process of examination are kept only to the dedicated examination staffs and the several checks and reviews are done before declaration of the results with proper confidentiality

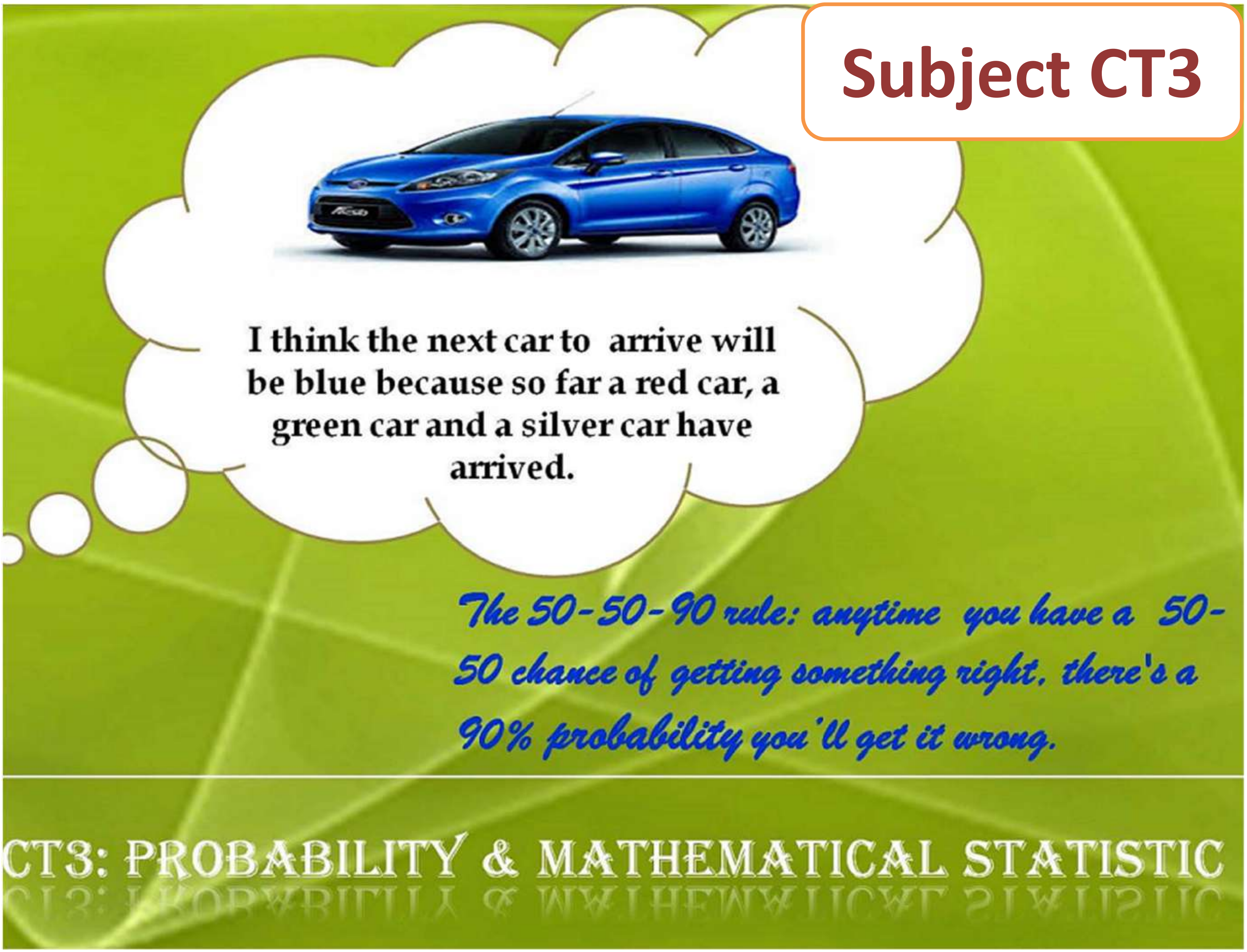
# Examination System ..(Contd)

- ❑ How to study Actuarial Examination?
  - ➢ Actuarial examination – how to tackle
  - ➢ Preparing for actuarial examinations
  - ➢ Enjoyment of study on the Subject

- ❑ Let us check one clip 3.avi

# Examination System ..(Contd)

- For passing the Actuarial examination the students require:
  - Clear Goal
  - Proper Planning
  - To drive or force in study
  - Full dedication
  - Thrill
  - Enjoy the Subject


Subject CT3
I think the next car to arrive will be blue because so far a red car, a green car and a silver car have arrived.
The 50-50-90 rule: anytime you have a 50-50 chance of getting something right, there's a 90% probability you'll get it wrong.
CT3: PROBABILITY & MATHEMATICAL STATISTIC

# Question No 5 of Oct 2009

**Q. 5)** Let $X$ and $Y$ be jointly distributed with probability density function,

$$f(x,y) = \begin{cases} \frac{1}{4}(1+xy), & |x|<1,\ |y|<1 \\ 0, & otherwise \end{cases}$$

Show that $X$ and $Y$ are not independent but $X^2$ and $Y^2$ are independent **[5]**

# Solution to Q No 5 of Oct 2009

**Q. 5)**

The marginal distribution of X is

$$f_1(x) = \int_{-1}^{1}\left[\frac{1}{4}(1+xy)\right] dy = \frac{1}{4}\left\{ [y]_{-1}^{1} + x\left[\frac{y^2}{2}\right]_{-1}^{1}\right\} = \frac{1}{2}, -1 < x < 1.$$

Similarly the marginal distribution of Y is $f_1(y) = \frac{1}{2}, -1 < y < 1.$

Now, $f_1(x) \times f_1(y) \neq f(x, y)$

Hence X and Y are not independent. [ 2 ]

$$P(X^2 \leq x) = P\left(|X| \leq \sqrt{x}\right) = \int_{-\sqrt{x}}^{\sqrt{x}} f_1(u)du = \left[\frac{u}{2}\right]_{-\sqrt{x}}^{\sqrt{x}} = \sqrt{x}$$

Similarly, $P(Y^2 \leq y) = \sqrt{y}$

$$P(X^2 \leq x \cap Y^2 \leq y) = P\left(|X| \leq \sqrt{x} \cap |Y| \leq \sqrt{y}\right) = \int_{-\sqrt{x}}^{\sqrt{x}}\left[\int_{-\sqrt{y}}^{\sqrt{y}} \frac{1}{4}(1+uv)du\right] dv$$

$$= \int_{-\sqrt{x}}^{\sqrt{x}}\left[\frac{1}{4}\left\{[u]_{-\sqrt{y}}^{\sqrt{y}} + v\left[\frac{u^2}{2}\right]_{-\sqrt{y}}^{\sqrt{y}}\right\}\right]dv = \int_{-\sqrt{x}}^{\sqrt{x}} \frac{\sqrt{y}}{2} dv = \frac{\sqrt{y}}{2}[v]_{-\sqrt{x}}^{\sqrt{x}} = \frac{\sqrt{y}}{2} \times 2\sqrt{x} = \sqrt{x} \times \sqrt{y}$$

$$= P(X^2 \leq x) \times P(Y^2 \leq y)$$

Hence $X^2$ *and* $Y^2$ are independent. [ 3 ]

## Question No 8 of Oct 2009

**Q.8)** An executive (HR) of a life insurance company desires to analyse the salaries of 27 actuarial staff employed by his company.

The Manager (HR) advised the executive that salary should be based on number of actuarial papers cleared and years of professional experience in life insurance industry.

Suggest a suitable statistical model to quantify, defining the symbols used.

**[3]**

# Solution to Q No 8 of Oct 2009

**Q.8)** The basic model would be:

$$E(Y \mid x_1, x_2) = \alpha + \beta_1 x_1 + \beta_2 x_2$$

Where,

$x_1$ = number of actuarial papers cleared

$x_2$ = number of years of professional experience in life insurance industry

$Y$ = Salary

$\alpha$ = (a constant), the average salary of new actuarial staff (with no paper cleared or professional experience)

$\beta_1$ = (a constant), the changes in salary associated with actuarial papers clearing

$\beta_2$ = (a constant), the changes in salary associated with years of professional experience in life insurance.

Since the data relates to 27 (= n) actuarial staffs, we need to introduce a sub script i corresponding to $i^{th}$ staff.

So the expression of the model for actual salary for the $i^{th}$ actuarial staff will be:

$$Y_i = \alpha + \beta_1 x_1 + \beta_2 x_2 + e_i$$

Where, $e_i$ *is* the difference between the actuarial staff's actual salary and the theoretical salary for someone with the same number of actuarial papers cleared and years of professional experience in life insurance industry [ 3 ]

# Question No 12 (a) of Oct 2009

**Q.12)** Let $Y$ be the number of patients dying in a region among x patients tested positive H1N1 virus, is to be modelled as a Poisson random variable with mean $\theta x$, where $\theta$ is unknown.

Suppose data is available from n independent regions: region $i$ with $x_i$ patients tested positive H1N1 virus of which $y_i$ have died, $i = 1, 2, 3, \dots\dots\dots, n$.

The least squares estimator of $\theta$ is that value of $\theta$ for which

$\sum_{i=1}^{n}\left(Y_i - E(Y_i)\right)^2$ is minimized.

**(a)** Show that the least squares estimator of $\theta$ is given by:

$$\bar{\theta} = \frac{\sum_{i=1}^{n} x_i Y_i}{\sum_{i=1}^{n} x_i^2} \qquad (3)$$

# Solution to Q No 12 (a) of Oct 2009

**Q.12) (a)** Let S = $\sum_{i=1}^{n}\left(Y_i - E(Y_i)\right)^2$ has to be minimized,

S = $\sum_{i=1}^{n}\left(Y_i - E(Y_i)\right)^2 = \sum_{i=1}^{n}(Y_i - \theta x_i)^2$

$\frac{dS}{d\theta} = -2\sum_{i=1}^{n} x_i(Y_i - \theta x_i)$, Setting $\frac{dS}{d\theta} = 0$, we get $\sum_{i=1}^{n} x_i Y_i - \theta\sum_{i=1}^{n} x_i^{\ 2} = 0$

$$\Rightarrow \bar{\theta} = \frac{\sum_{i=1}^{n} x_i Y_i}{\sum_{i=1}^{n} x_i^2}$$

[ 2 ]

$\frac{d^2S}{d\theta^2} = 2\sum_{i=1}^{n} x_i^{\ 2} > 0$

Hence, $\bar{\theta}$ is the least square estimator

[ 1 ]

# Question No 12 (b),(c) & (d) of Oct 2009

**(b)** Find $\bar{\bar{\theta}}$, the maximum likelihood estimator of $\theta$. (3)

**(c)** Examine whether $\bar{\theta}$ and $\bar{\bar{\theta}}$ provide unbiased estimators of $\theta$. (2)

**(d)** The table below gives the region- wise patients affected by H1N1 virus and the number of patients died:

| Region | Number of patients affected by H1N1 virus | Number of deaths |
|---|---|---|
| 1 | 41,773 | 534 |
| 2 | 77,578 | 1,025 |
| 3 | 1,205 | 2 |
| 4 | 22,422 | 74 |
| 5 | 9,965 | 97 |
| 6 | 29,223 | 67 |

Find the value of $\bar{\theta}$ and $\bar{\bar{\theta}}$ from the given data. (3)

# Solution to Q No 12 (b) of Oct 2009

**(b)** L (θ) = $e^{-\sum x_i\theta} \prod (x_i\theta)^{Y_i}$ × Constant

Log(L(θ)) = $-\theta \sum x_i + \sum Y_i \log(\theta)$ + Constant

$$\frac{dLog(L(\theta))}{d\theta} = -\sum x_i + \frac{1}{\theta}\sum Y_i \text{, Setting to 0} \Rightarrow \bar{\bar{\theta}} = \frac{\sum Y_i}{\sum x_i}$$ [ 2 ]

$$\frac{d^2Log(L(\theta))}{d\theta^2} = -\frac{1}{\theta^2}\sum Y_i = \left[-\frac{1}{\theta^2}\sum Y_i\right]_{\bar{\bar{\theta}} = \frac{\sum Y_i}{\sum x_i}} < 0$$

Hence, $\bar{\bar{\theta}}$ is the maximum likelihood estimator [ 1 ]

# Solution to Q No 12 (c) of Oct 2009

**(c)** $$E(\bar{\theta}) = E\left(\frac{\sum_{i=1}^{n} x_i Y_i}{\sum_{i=1}^{n} x_i^2}\right) = \frac{1}{\sum_{i=1}^{n} x_i^2} E\left(\sum_{i=1}^{n} x_i Y_i\right) = \frac{1}{\sum_{i=1}^{n} x_i^2}\left(\sum_{i=1}^{n} x_i \theta x_i\right) = \theta$$

Hence unbiased estimator [1]

$$E(\bar{\bar{\theta}}) = E\left(\frac{\sum_{i=1}^{n} Y_i}{\sum_{i=1}^{n} x_i}\right) = \frac{1}{\sum_{i=1}^{n} x_i} E\left(\sum_{i=1}^{n} Y_i\right) = \frac{1}{\sum_{i=1}^{n} x_i}\left(\sum_{i=1}^{n} \theta x_i\right) = \theta$$

Hence unbiased estimator [1]

# Solution to Q No 12 (d) of Oct 2009

**(d)** From the given data,

$\sum x_i = 182{,}166; \quad \sum y_i = 1{,}799; \quad \sum x_i\, y_i = 106{,}410{,}416; \quad \sum x_i^2 = 9{,}220{,}812{,}676$ [ 2 ]

$$\Rightarrow \bar{\theta} = \frac{\sum x_i Y_i}{\sum x_i^2} = \frac{106{,}410{,}416}{9{,}220{,}812{,}676} = 0.01154$$ [$\frac{1}{2}$]

$$\Rightarrow \bar{\bar{\theta}} = \frac{\sum Y_i}{\sum x_i} = \frac{1{,}799}{182{,}166} = 0.00988$$ [$\frac{1}{2}$]

# Question No 6 of May 2010

**Q.6)** There are two continuous probability distributions:

A is an exponential distribution with mean $\theta = 7$

B is a distribution that is uniform on the interval from 0 to 8, and thereafter proportional to A.

Show that the probability of a random variable that follows distribution B and lying between 0 and 8 is 8/15 **[5]**

# Solution to Q No 6 of May 2010

Q.6) We can define the probability density function (pdf) of B as a system of two equations with two unknowns:

$$f(x) = c \qquad for\ 0 \le x \le 8;$$

$$= \frac{k}{7}\, e^{-\frac{x}{7}},\ \ for\ x \ge 8$$

At x = 8, we have, $f(8) = \frac{k}{7}\, e^{-\frac{8}{7}} = c$

We also know that the area underneath a pdf must equal 1.

Thus, 8c + $\int_{8}^{\infty} ke^{-\frac{x}{7}}/7dx$ = 1

=> 8c + $\left| -ke^{-x/7} \right|_{8}$ = 1

=> 8c + $ke^{-8/7}$ = 1. But c = $\frac{k}{7}e^{-8/7}$, so $ke^{-8/7}$ = 7c, and therefore 8c + 7c = 1 and so c = 1/15.

Over the interval 0 ≤ x ≤ 8, the area underneath the pdf is 8c = **8/15**

# Question No 16 of May 2010

**Q.16)** An actuary recorded the length of time, y minutes, taken to travel to office when leaving home x minutes after 7 am on seven selected mornings. The results are as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| x | 0 | 10 | 20 | 30 | 40 | 50 | 60 |
| y | 16 | 27 | 28 | 39 | 39 | 48 | 51 |

(a) Plot the data on a scatter diagram. (1)

(b) (i) Calculate the equation of the least squares regression line of y on x, writing your answer in the form y = a + bx. (4)

(ii) Draw the regression line on your scatter diagram. (2)

(c) (i) Calculate a two-sided 95% confidence interval for b, the slope of the regression line. (3)

(ii) Hence or otherwise, test the hypothesis $H_0$ : b = 1 vs $H_1$ : b ≠ 1 at 5% level of significance. (1)

(d) The actuary needs to arrive at office no later than 8:40 am. The number of minutes by which the actuary arrives early at office, when leaving home x minutes after 7 am, is denoted by z.

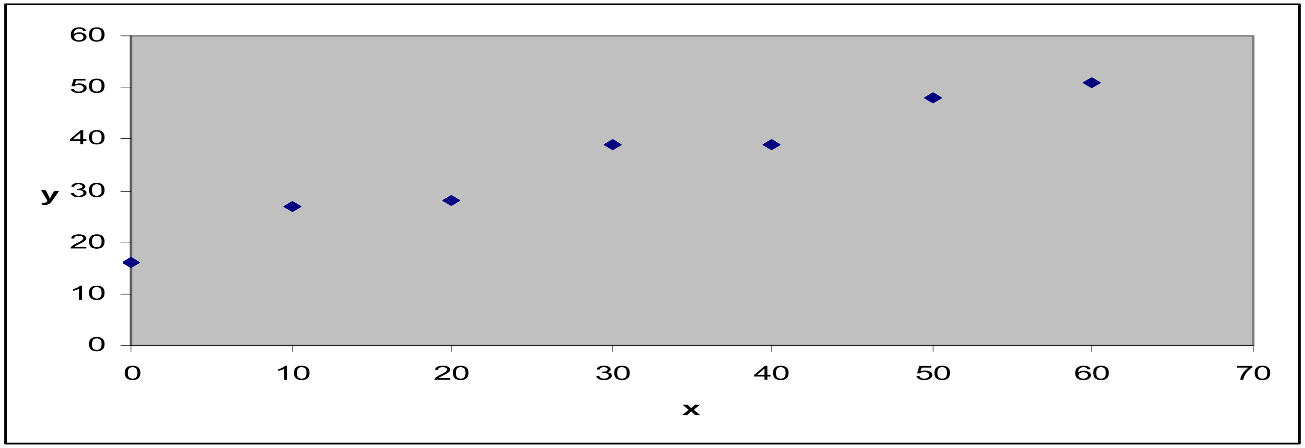
(i) Deduce that z can be estimated by, z = 81.5 – 1.564x (2)

(ii) Hence estimate, to the nearest minute, the latest time that the actuary can leave home without then arriving late at office. (1)

**[14]**

# Solution to Q No 16 of May 2010

**Q. 16** (a)




(b) (i)

| | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| x | 0 | 10 | 20 | 30 | 40 | 50 | 60 | **210** |
| y | 16 | 27 | 28 | 39 | 39 | 48 | 51 | **248** |
| xy | 0 | 270 | 560 | 1,170 | 1,560 | 2,400 | 3,060 | **9,020** |
| $x^2$ | 0 | 100 | 400 | 900 | 1,600 | 2,500 | 3,600 | **9,100** |

$S_{xy} = \sum x_i y_i - \sum x_i \sum y_i / n = 9020 - 210 * 248 / 7 = 1,580$

$S_{xx} = \sum x_i^2 - (\sum x_i)^2/n = 9100 - 210^2 / 7 = 2,800$

$\hat{b} = S_{xy} / S_{xx} = 1580 / 2800 = 0.564$

$\hat{a} = \bar{y} - b\bar{x} = (248 / 7) - 0.564 * (210 / 7) = 18.5$

y = 18.5 + 0.564x

b(ii) Draw a line joining the two (x, y) co-ordinates: (0, 18.5) and (60, 52.4)

# Solution to Q No 16 of May 2010 – (Contd)

(c) (i) $\sigma^2 = (S_{yy} - S^2_{xy}/S_{xx}) / (n - 2)$

$S_{yy} = \sum y_i^2 - n\bar{y}^2 = 9716 - 248^2 / 7 = 929.71$

Thus, $\sigma^2 = (929.71 - 1580^2 / 2800) / 5 = 7.63$

$se(\hat{b}) = (\sigma^2 / S_{xx})^{1/2} = (7.63 / 2800)^{1/2} = 0.0522$

95% confidence interval for b is $\hat{b} \pm \{t_{0.025,5} * se(\hat{b})\}$

$= 0.564 \pm (2.571 * 0.0522)$

So 95% confidence interval is (0.430, 0.698)

c(ii) The 95% two-sided confidence interval does not contain the value “1”, so the two-sided test conducted at 5% level results in $H_0$ being rejected.

(d) (i) Difference between 8:40 am and 7 am is 100 minutes.

$\hat{z}$ = Time available – Time taken

$= (100 - x) - y$

$= (100 - x) - (\hat{a} + \hat{b}x)$

$= 81.5 - 1.564x$

(ii) $\hat{z} = 81.5 - 1.564x$

For $\hat{z} = 0$, $x = 81.5 / 1.564 = 52.11$, taken equal to 52 minutes as approximation.

The latest time is therefore 7:52 am.

# Question No 3 of November 2010

**Q. 3)** Suppose the probability of an individual being born on any particular day of the year is given by 1/365.

(a) What is the probability that 2 people meeting at random have the same birthday? (2)

(b) Suppose now that a group has 3 individuals. What is the probability that at least two of these individuals will share a birthday? What if the group has 4 individuals? (4)

(c) Show that a group must have 15 individuals such that the probability of finding at least 2 people with the same birthday is 25%. (3)

**[9]**

# Solution to Q No 3 of November 2010

**3. (a)** Suppose that person1 is born on a particular day i, where i can be any one of the 365 days. So probability = 1/365

If person2 does not share the same birthday, then he should have born on any one of the rest 364 days. So probability = 364/365

Finally, there can be such 365 combinations as i can be any of the 365 days

Probability of 2 persons not having the same birthday is

$1/365 * 364/365 * 365 = 365*364/365^2$

Thus, probability of 2 persons having the same birthday is $1-365*364/365^2 = 0.002740$

**(b)** Let all 3 persons do not share the same birthday whose probability based on above argument is $1/365 *364/365 * 363/365*365 = 365*364*363/365^3$

Thus, probability of at least 2 persons having the same birthday is

$1-365*364*363/365^3 = 0.008204$

For a group of 4 persons, the probability at least 2 persons having same birthday would be
$1- 365*364*363*362/365^4 = 0.016356$

**(c)** Let the group size be 15
Thus, for a group of 15 persons, the probability that at least 2 persons have the same birthday would be
$1- 365*364*…(365-15+1)/365^{15}$

$= 1- 0.7471 = 0.2529$

# Question No 5 of November 2010

**Q.5** Vivek's company owns a factory. It buys insurance to protect itself against major repair costs. Profit equals revenues, less the sum of insurance premiums, retained major repair costs, and all other expenses. Company will pay a dividend equal to the profit, if it is positive.

You are given:

(i) Revenue from the factory is 1.70.

(ii) The distribution of major repair costs (k) for the factory is

| | *Probability* |
|---|---|
| *0* | *0.4* |
| *1* | *0.3* |
| *2* | *0.2* |
| *3* | *0.1* |

(iii) The insurance policy pays the major repair costs in excess of that factory's deductible of 1 (i.e. claims will be payable after deducting 1 provided claims are greater than 1, else nil). The insurance premium is 110% of the expected claims for the insurance company.

(iv) All other expenses are 20% of revenues.

Show that the expected dividend is equal to 0.368.

# Solution to Q No 5 of November 2010

**Sol.5)** Expected claims for the insurance company = 1*0.2 + 2*0.1 = 0.4

Insurance Premium = 110% * 0.4 = 0.44

Revenue = 1.70

Other Expenses = 20% * 1.70 = 0.34

Profit before repair cost = 1.70 – 0.34 – 0.44 = 0.92

Retained repair cost = 0 with probability 0.4

= 1 with probability 0.6

Profits after retained repair cost = 0.92 with probability 0.4

= -0.08 with probability 0.6

Thus, expected dividends = 0.92*0.4 + 0*0.6 = 0.368

# Question No 15 of November 2010

**Q.15)** Anand obtains cash from an ATM (cash machine) for his girlfriend. He suspects that the rate at which she spends cash is affected by the amount of cash he withdrew at his previous visit to an ATM.

To investigate this, he deliberately varies the amounts he withdraws. For the next 10 withdrawals, he records, for each visit to an ATM, the amount x (in Rs.) withdrawn, and the number of hours, y, until his next visit to an ATM.

| Withdrawal | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| x | 40 | 10 | 100 | 110 | 120 | 150 | 20 | 90 | 80 | 130 |
| y | 56 | 62 | 195 | 240 | 170 | 270 | 48 | 196 | 214 | 286 |

(a) Calculate the equation of the regression line of y on x (4)

(b) Interpret, in context of the question, the gradient of the regression line (1)

**[5]**

# Solution to Q No 15 of November 2010

**Sol.15)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| x | 40 | 10 | 100 | 110 | 120 | 150 | 20 | 90 | 80 | 130 | **850** |
| y | 56 | 62 | 195 | 240 | 170 | 270 | 48 | 196 | 214 | 286 | **1,737** |
| xy | 2,240 | 620 | 19,500 | 26,400 | 20,400 | 40,500 | 960 | 17,640 | 17,120 | 37,180 | **182,560** |
| $x^2$ | 1,600 | 100 | 10,000 | 12,100 | 14,400 | 22,500 | 400 | 8,100 | 6,400 | 16,900 | **92,500** |

**[1**

$S_{xy} = \sum x_i y_i - \sum x_i \sum y_i / n = 182560 - 850 * 1737/10 = 34915$

$S_{xx} = \sum x_i^2 - (\sum x_i)^2/n = 92500 - 850^2/10 = 20250$

$\hat{b} = S_{xy} / S_{xx} = 1.72$

$\hat{a} = \bar{y} - b\bar{x} = (1737/10) - 1.72 * (850/10) = 27.14$

$y = 27.14 + 1.72x$

**(b)** Gradient represents the amount of hours per rupee spent


Conclusión

# Concluding remark

- Passing the actuarial paper with in time is not impossible
- We have to believe ourselves to understand the subject and have clear understanding
- If you believe in who you are, what you are, how you can do this, you will always be the winner.
- 4.avi


THANK YOU FOR YOUR ATTENTION