Institute of Actuaries of India

Subject ST5 – Finance and Investment A

May 2011 Examinations

INDICATIVE SOLUTIONS

Introduction

The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiner have given credit for any alternative approach or interpretation which they consider to be reasonable.

Q1.)

The four steps used by credit rating companies to evaluate the entities proposing to issue debt paper are:

<u>Purpose:</u>

It involves understanding the entity current business and the reasons for intent to borrow money. Possible reasons for seeking finance include:

- Organic growth
- Acquisition
- Investment in an associated company
- New capital expenditure
- Finance for share buy-back or paying dividends.

<u>Payback:</u>

This relates to the ability to repay the loan. What are the expected sources of loan repayments? Issues need to consider are:

- Cash-flow profile
- Possible sale of assets and/or business
- Refinancing

<u>Risks:</u>

This relates to the character and ability of the borrower and its ability to repay.

Identification of quantitative and qualitative risks which could jeopardize debt servicing. Main factors to consider are:

- Macro considerations:

  - Industry analysis and competitive trends – to understand the growth prospects for the industry as a whole and how the total market will be split between the different companies operating within the industry.

  - Regulatory environment – regulatory changes which might change the way that affects the financial position of the company.

  - Sovereign macroeconomics analysis – herein economic analysis is done to understand the state of the economy in which the company operates.

- Company specific issues:

  - Qualitative analysis – factors such as company's management, technology, range of goods and services etc.

  - Financial performance – it involves trends in its financial ratios (profitability, liquidity etc), both historical trends and projections of future trends.

  - Market position – relative to its competitors as measured by market share etc.

Structure:

This relates to the structuring of bonds which reflect the inherent risks and protection of investors' interests. This includes terms and conditions of the particular bond issue, like:

- Term of the bond and level & frequency of coupons
- Its ranking relative to other bonds issued by the company
- Provisions related to further bond issues
- Any limits on income and asset cover
- The quality and value of assets on which it is secured
- Borrower's ability to vary the assets on which it is secured
- Price and yield at which bonds are to be issued and yield margin over risk-free government bonds.

[Total Marks -10]

Q2.)

Asset classes to minimize Market risk

Being risk averse, trustees will prefer asset which reduces or eliminates the risk of fall in asset values. Asset classes which have minimum market risk are:

1) Floating rate bonds
2) Cash investments like Certificate of deposits, commercial papers
3) Short term fixed interest bonds
4) Medium to long term fixed interest bonds along with interest rate swaps to swap fixed payments with floating interest payments

Asset classes to minimize Credit risk

Being risk averse, trustees will prefer asset which reduces or eliminates the risk of default or fall in credit ratings of asset values. Asset classes which have minimum credit risk are:

1) Bonds or T-bills issued by Government of India (GOI)
2) High quality AAA rated bonds issued by Public sector undertakings/other institutions with GOI guarantees
3) High quality AAA rated bonds issued by big private sector companies with adequate credit default swaps cover.
4) Bonds issued by Federal government of developed nations with adequate foreign exchange swaps/futures cover

[Total Marks – 5]

Q3.)

(i)

Purchase 1- Amco Stock

- Anchoring– your friend has a view of the stock and how it will grow. The view on growth is anchored on past performance

- Overconfidence – your friend is overconfident in his ability to predict future performance of Amco and its stock price.

- Regret aversion – by retaining the existing shares, your friend will not suffer from regret if he sells Amco, invests in the competitor and Amco stock outperforms the competitor.

- Status Quo bias – people have preference to keep things as they are, so your friend has decided to keep all existing investments in Amco, and has the ignored advice of his broker.

Purchase 2- Guranteed Bond

- Framing – he has framed the decision in such a way as to make the alternative (risky) bond seem poor value even though it offers a higher expected return.

- Regret aversion – if your friend held the alternative (risky) bond and the actual return turned out to be 0%, he would have regretted not holding the guaranteed bond.

- Risk averse/myopic loss aversion – prefers to hold a guaranteed return as he places more weight on the downside return of the alternative investment rather than the upside

(ii)

- Regret aversion — Feeling of sorrow after making a decision which turns out to be wrong. e.g the new manager underperforms and the old manager outperforms.
- Familiarity bias — people attach less risk to things with which they are familiar with. Trustees may decide to retain an existing manager or appoint a local manager rather than a new, unknown manager.
- Past Performance bias — past performance data has a tenuous link to future performance. Trustees may attach too much weight or significance to past performance data when making their manager selection.
- Herding instinct/peer group behaviour — hire a well known manager, reduce scope for peer criticism if it goes wrong.

[Total Marks – 6]

Q4.)

(a) Index weighted on 'free float' of constituents means that instead of using complete market capitalization as weights capitalization based on the 'free float' of the shares available for purchase is considered as weight, thereby eliminating strategic holdings.

If a constituent has say 75% promoter holding and rest 25% with general investors, the capitalization used as a weight is only 25% of the market capitalization of the company.

$$I(t) = k*((\sum w_i * p_{i,t} / p_{i,0})/(\sum w_i))$$

Wherein:

$I(t)$	:	Index value at time 't'
$p_{i,t}$	:	Price of the ith constituent at time 't'
$p_{i,0}$	:	Price of the ith constituent at time '0'
w_i	:	Weight based on free floating market capitalization of the ith constituent
k	:	Constant value related to index at time '0'.

It is advantageous to use weights based on free float as compared to complete market capital because the shareholding used for strategic purposes are not traded in market and therefore can create artificial scarcity of shares in market.

(b) **Free float of Hero Honda:**

(60%*(25%)*(10,000,000,000)/10)*600 = x%*(150,000,000)*1600

X = 37.5%

Now, at T = 0,

$$I(0) = (\sum N_{i,0} * P_{i,0}) / B(0)$$

B(0) : Base value or divisor at T = 0
I(0) : Index value at T = 0
$N_{i,0}$: No. of outstanding free float shares of ith company at T = 0
$P_{i,0}$: Share price of ith company at T = 0

Therefore, 1000 = (100/8)* (((25%)*(10,000,000,000)/10)*600 + 37.5%*(150,000,000)*1600) / B(0)

So, B(0) = 3,000,000,000

So total representation of other 48 companies in NIFTYTR was:

(92/8)* ((25%)*(10,000,000,000)/10)*600 + 37.5%*(150,000,000)*1600)

=2,760,000,000,000

$$I(1) = (\sum N_{i,1} * P_{i,1}) / B(0)$$

I(1)   =(2,760,000,000,000   +   (((25%)*(10,000,000,000)/10)*650   + 37.5%*(150,000,000)*2000))/3,000,000,000 = 1,011.67

Promoter's holding in Wipro post public issue is 500 million shares ie 50% and increase in the free float is from 250 million shares to 500 million shares.

Theoritical dilution of promoters holding should have no impact on Wipro's representation to the index, so an increase in the free-float should be compensated by a reduction in share price.

So theoretical share price of Wipro post public issue should be:

((25%)*(10,000,000,000)/10)*650 = ((50%)*(10,000,000,000)/10)*Y

So Y = 325

Theoritical ex-Rights price of Hero Honda should be = ((3*2000) + (1*1,800))/4 = 1,950

At no gains/losses, the capital index value at T = 1, should remain the same as increase in market capitalization because of Public issue and Rights issue don't change the index value.

So, I(1) = (2,760,000,000,000 + (((50%)*(10,000,000,000)/10)*325 + 37.5%*(200,000,000)*1,950))/B(1) = 1,011.67

So, B(1) = 3,033,360,791

Now, actual ex-public issue share price of Wipro = 550
Actual ex-rights share price of Hero Honda = 1.05*1950 = 2047.5

So, capital index value at T = 1

I(1) = (2,760,000,000,000 + (((50%)*(10,000,000,000)/10)*550 + 37.5%*(200,000,000)*2,047.5))/3,033,360,791 =   1,051.16

So, Total Return index value of NIFTYTR 50 at T = 1 is:

(2,760,000,000,000 + (((50%)*(10,000,000,000)/10)*550 + 37.5%*1.02*(200,000,000)*2,047.5))/3,033,360,791 = **1052.177**

[Total Marks – 15]

Q5.)

The 20% CAGR of ABC was a money weighted rate of return (MWRR).

$1*(1+MWRR)^2 + 1.5*(1+MWRR)^1 = 3.24$

It is not proper to use MWRR when large cash-flow occurs in the performance measurement period.

The time weighted rate of return (TWRR) of ABC (assuming fund size of Rs. 1 billion as on 31 Dec 2009 in line with the index) was:

TWRR, $(1/1)*(3.24/2.5) = (1+i)^2$

Therefore, i = 13.84%

The rate of returns of ETF was 16%, therefore past performance of two years indicates a better performance by ETF as compared to ABC.

[Total Marks – 5]

Q6.)

(i)   Hedge funds were originally characterised by:

- The placing of many large bets on different assets
- A high level of borrowing given the limited size of capital of the funds compared to the size of individual investments
- A mix of investments for which the price movements would be expected mostly to cancel each other out, except for the positive effect the hedge fund is looking for
- A willingness to trade in derivatives, commodities and non-income bearing securities

(ii)
- Return on capital = profit / Rs 200,000 capital invested
- profit = income return + capital return (see table below)
- Calculation only allows for information stated in question (ignores other transaction costs in the trade).

Return Source	Return	Notes
(1) Income returns		
Bond interest income (on long bond)	37383.17757	Coupon is 4% of face value of investment. =0.04* number of bonds purchased * 100 =0.04* (1,000,000/107)*100.
Short interest rebate (i.e interest earned on proceeds of short sale)	7500	Interest earned is 1.25% of short sale proceeds which =0.0125*25000*24.
Less		
Cost of leverage	(16000)	800,000 was borrowed at a cost of 2%.
Dividend payment (on short stock)	(6000)	Manger owes Rs 0.24 dividend on each of the 25,000 shares sold short.
Total income (1)	**22883.17757**	
(2) Capital (arbitrage) returns		
Bond return	112149.5327	gained 12 (119-107) per bond so total gain =number of bonds*12 = (1000000/107)*12

Stock return	(75000)	lost 3 per share (27-24) so loss on short sale was 25000*3
Total capital (arbitrage) gains (2)	**37149.53271**	
Total profit (1)+(2)	**60032.71028**	Total profit made by manger over the year
Return on capital invested	<u>**30.02%**</u>	Return on 200,000 invested (i.e 60,032/200,000)

(3 marks for income return; 2 for capital return; 1 for total return = max 6 marks)
The question stated that the long position in the convertible bond was "Rs1,000,0000"
wheras the intention was a position of Rs1,000,000
Therefore, solutions based on both versions were allowed.

(iii)

- **Credit Default Swap -** Hedge fund manager pays a fee to a counterparty (protection seller). The CDS gives the manager the right to receive a payment in the event of an agreed change in the credit status of A's convertible bond.

- **Credit Spread Option –** Hedge fund manager pays a fee to a counterparty for this option. This option gives the manager the right to sell A's convertible bond at a predetermined (strike) spread over a reference yield (e.g Treasury or LIBOR). This protects the manager if the spread on A's convertible bond widens and exceeds the strike spread.

- (Note if credit spreads widen, some of the price reduction in the convertible bond may be offset by a fall in share price and gain on the short position, assuming the increased default expectations cause the share price fall. This may not give complete protection, so the credit derivatives above may provide better a hedge for credit risk.)

[Total Marks – 10]

Q7.)

(i)

- Basis risk can be defined as "the residual risk that results when the two sides of a hedge do not move exactly together."

Sources of basis risk include:

- The asset whose price is to be hedged is not exactly the same as the asset underlying the futures contract
- The hedger is uncertain as to the exact date when the asset will be bought or sold.
- The hedge requires the futures contract to be closed out well before its expiration date.

(ii)

- The insurer is effectively writing a Put option on residential property values against the value of the accumulated non-interest bearing loans.
- *Such an option could be valued using the Black-Scholes formula, where S is the current value of a residential property, K is the strike price of the Put option and equal to the initial loan accumulated for T years at rate 3%, r is the continuously compounded risk-free interest rate for term T, σ is the volatility of the residential property price.*
- To hedge its position, the insurer would purchase Put options on a relevant house price index. However, this would be retaining considerable basis risk because the distribution of the properties by region and size is unlikely to be identical to that underlying whatever index the option is based on.
- There is also unlikely to be a liquid market in options on residential property, even over the counter.
- In practice T is not fixed (term of the guarantee) since it is contingent on the lifetime of the last survivor, so finding derivative hedges of the required term is difficult.

(iii)

Axel Re securitizes the expected margin – the difference between the expected payments and the actual payments.

Parties and Cash Flows

Axel Re
- Reinsures the longevity risk from the direct writer (receives expected, pays actual).
- Assigns longevity risk cash flows to SPV.
- Receives cash from SPV.
- Purchases credit enhancement from 3rd party guarantor.

Special Purpose Vehicle
- Assigned longevity risk cash flows from Axel Re.
- Pays cash to Axel Re as compensation for future longevity risk cash flows.
- Repackages future longevity risk cash flows as securities, issues securities to capital markets.

(1)

Investors
- Receives payments from securities issued by SPV.
- Pays cash for securities to SPV.
- Receives payment from 3rd party guarantor in event of default.

3rd Party Guarantor
- Receives premium from Axel Re for providing guarantee.
- Makes payment to investors in event of default.

[Total Marks – 8]

Q8.)

(i)

- Company B pays 1.4% per annum more than company A in fixed rate markets and only 0.5% per annum more than company A in floating rate markets. Company B appears to have a comparative advantage in floating rate markets whereas company A appears to have a competitive advantage in fixed rate markets. Therefore a swap can be negotiated

- Company A borrows fixed rate funds at 12.0% per annum. Company B borrows floating rate funds at LIBOR plus 0.6% per annum. They then enter into a swap agreement to ensure that A ends up with floating rate funds and B ends up with fixed rate funds.

- The total apparent gain in this type of interest rate swap agreement is always (a – b), where "a" is the difference between the interest rates facing the two companies in fixed rate markets, and "b" is the difference between the interest rates facing the two companies in floating rate markets. In this case, "a" = 13.4 – 12.0 = 1.4, and "b" = 0.6 – 0.1 = 0.5.

- The total gain, ignoring the intermediary, is 1.4 – 0.5 = 0.9. After allowing for the intermediary's profit, the total gain will be 0.9 – 0.1 = 0.8.

- A swap that has to be equally attractive to both companies, after paying the intermediary could be:

- **Company A:**
  - it pays 12% to outside lenders
  - it receives 12.3% per annum from the B via the intermediary
  - it pays LIBOR to B.
  - The net effect of the three cash flows is that A pays LIBOR minus 0.3% per annum.
  - This is 0.4% less than it would pay if it went directly to floating rate markets.

- **Company B:**
  - it pays LIBOR plus 0.6% to outside lenders
  - it receives LIBOR from A
  - it pays 12.4% to the intermediary (who in turn pays 12.3% to A)
  - The net effect of the three cash flows is that B pays 13% per annum.

  - This is 0.4% less than it would pay if it went directly to fixed rate markets.

- The intermediary makes 0.1%.

- Diagram below represents the exchange of cash flows.

   (Correct diagram/solution reasoning should be awarded 5 marks; award partial marks ranging from 1-3 for partial solutions which show similar reasoning to the first 4 bullets)
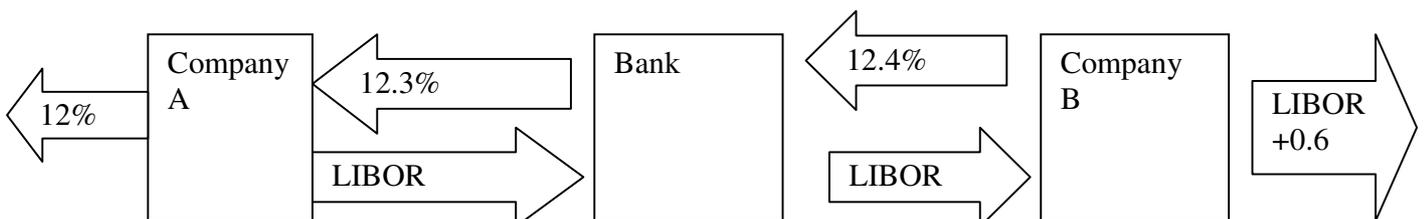
(ii)
- We need to calculate the value of both swaptions and add them together.
- First we need to derive the yield curve from the bond prices.
- Let g be the coupon of a bond, B is the bond price and matures in year t; and d(t) is discount factor at time t.

- Bond formula B = g($\sum$d(j))+ 100d(t) – with the sum applying between years j=1 and j= t.

- So d(t) can be solved iteratively using bootstrapping to give   d(t) = (B – g $\sum$d(j)) / (100+ g)
  The sum applies for years j=1 to j=t-1.

- These are derived in the table below. For the valuation, the discount factor d(t) is needed.

Term (Years)	Coupon %	Price	Discount Factor d(t)	Zero Coupon rate (annual compounding)
1	5	99.876	0.95120	5.13036%
2	5.25	99.97	0.90239	5.26977%
3	6	101.882	0.85623	5.31002%
4	4.75	98.072	0.81337	5.29994%
5	4.5	96.88	0.77537	5.22011%

- The swaption calculations are shown in the table below:

The first swaption is a payer swaption

		The remaining allocation of the 10 marks Is in bold below
L	10,000,000	
A	2.44496	A = d(3)+d(4)+d(5)
F	0.051952288	F= Forward swap rate is solution to:
X	0.042	F(d(3)+d(4)+d(5))+d(5) = d(2)
SIGMA	0.17	
T	2	
d1	1.004741105	
d2	0.764324799	
N(d1)	0.842489235	
N(d2)	0.777663145	

Value= LA (FN(d1)-XN(d2)

271571.8089

**The second swaption is a
receiver swaption**

L	20,000,000	
A	1.58873	A = d(4)+d(5)
F	0.0508995	
X	0.033	F= Forward swap rate is solution to:
SIGMA	0.19	F(d(4)+d(5))+d(5) = d(3)
T	3	
d1	1.481345693	
d2	1.152256039	
N(-d1)	0.069257239	
N(-d2)	0.124607938	

Value= LA (XN(-d2)-FN(-
d1))

18648.65623

Total Value of Swaptions   **Rs.**   **290,220.47**

[Total Marks – 18]

Q9.)

(i)
- If a hedge is to be successful, then the value of the option must move in line with the underlying assets.
- The delta of an option is the derivative of the option price with respect to the underlying asset price i.e it measures the rate of change of the value of the option to a small change in the underlying asset.
- The number of options required for each unit of the asset is equal to the inverse of the delta. Delta varies with time to expiry, asset price relative to exercise price and the volatility of the underlying security so an absolutely accurate hedge will require adjustment of the no. of contracts held.

(ii)

- No.of shares we need to hedge is (Rs 600,000,000/Rs500)*(1/2) = 600,000
- We need to buy 600,000*(1/0.6) put options = 1,000,000   (note that if x is the required number of put options, then to be delta neutral implies 600,000*1 + x *(-0.6) = 0 which implies that x = 600,000/0.6)

- Cost = 1,000,000*30 = Rs 30,000,000

(iii)

- You will buy the index in 1 year in the spot market.
- However, to guarantee you are effectively buying at 1025, you need to buy 1 call (strike 1025) and sell 1 put (strike 1025); these options have term 1 year, and the underlying is the Mini SENSEX index.
- Suppose you buy the index for X where X>1025. The losses you make by purchasing for more then 1025 are offset by gains on the long call option.
- Suppose you buy the index for X where X<1025. The gains you make by purchasing for less then 1025 are offset by losses on the short put.
- The cost of this strategy is C-P, where C&P are the call/put premiums.
- By put call parity (since this is an arbitrage free market) C-P = S – Present value of exercise price = 1000 – 1025/1.05 = 23.81, which is the cost of the strategy

(iv) (a) (Mark allocation = 1 for assumptions, 2 for strategy X, 3 for strategy Y = Total 6 marks)
- Define net return as 100*(Net payoff at expiry / option premium), where net payoff = gross payoff less the premium paid at inception.
- Ignore any other transaction costs in trading, and the time value of money.
- Below is a table of possible strikes/premiums if strike A is set to 100 & a graph of net payoffs, which indicates how each strategy behaves with the stock price.

Option (by Strike)	Exercise Price	Put Premium	Call Premium
A	100	5.00	6.00
B	109	6.54	6.76
C	80	1.60	3.20
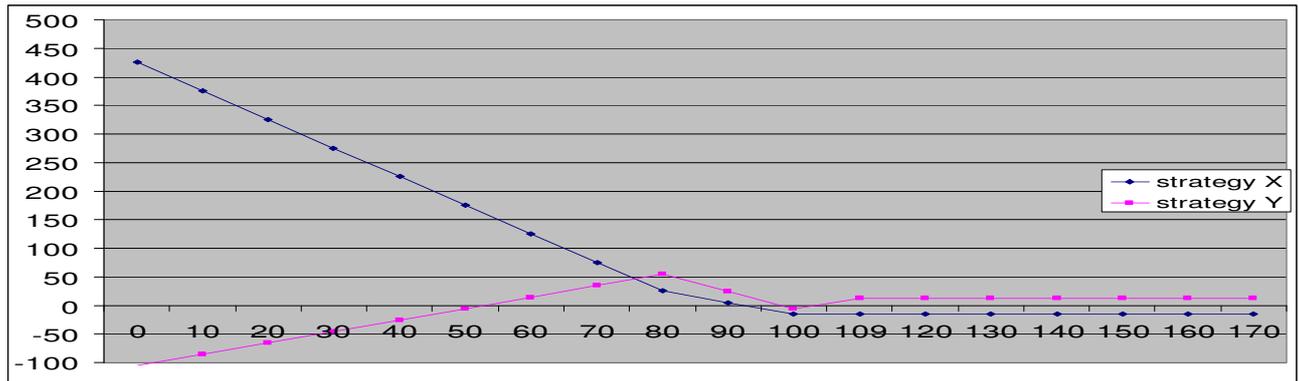
(1) Strategy X (2 long puts A & 3 long puts C)

- Cost of position = 2*5.00+ 3*1.60 =14.80
- Max gross payoff   clearly occurs when stock price is 0 and this equals 2*100+3*80=440. Therefore maximum net return is (440 – 14.80 / 14.80   ) * 100 = **2872.97%**
- Maximum Loss = cost of establishing position = 14.80, so minimum net return = **-100% by definition.**

(2) Strategy Y (2 long calls strike A,2 short calls strike B, 3 long puts strike A, 5 short puts strike C)

- Cost of position = 2*6.00-2*6.76+3*5.00-5*1.60 = 5.484
- The maximum payoff clearly occurs at strike C at the left peak – since we have bought more puts than calls (3vs2), and C is further away from A than B is, so the gain at C should be more. (*see check below)
- Maximum payoff at C = 3*(100-80) = 60 so Maximum Net return = 100* (60-5.484)/5.484 = **994.09%**
- Maximum loss clearly occurs when stock price falls to 0.
- At 0 only the put options will payoff, since the calls will payoff 0. The maximum loss = 3*100-5*80=-100. Therefore, minimum net return = 100* (-100 –5.484)/5.484 = **-1923.49%.**
- (* As a check profit at B at the right peak = 2(109-100) = 18, which is lower than profit of 60 at strike C at the left peak)

(b)
- The question says "minor alteration"- so no credit given if candidate states "make both strategies identical"!!
- On strategy Y, we could sell 3 put options (strike C) instead of selling 5 put options(strike C). This will then produce a flat line at the left peak.
- Since we are now selling 2 fewer put options, the cost of the position would now increase to 8.684 (5.484+2*1.60=8.684). Therefore this altered strategy requires the trader to invest more money at outset.
- Now the greatest loss occurs if the price remains at strike A (see diagram).
- If the price remains at A, the trader loses his investment, so the minimum net return becomes -100%. This is equal to X's minimum return.

(marks – award 3 for correct solution and reasoning, award 1 mark for any reasonable attempts)

[Total Marks – 16]

Q10.)

(1)   Information Ratio: Information ratio is defined as the ratio of average of relative returns to tracking error of portfolio or stock.

Information ratio = Average of relative returns/Tracking error

While comparing two funds, the fund with higher information ratio suggests out-performance of that fund with respect to the other fund.

(2)   Investor is concerned with post expenses performance of the mutual funds, therefore, ignoring the expense ratios of the funds.

Information Ratios:

Date	R_M (NIFTY)	R_A(ABC)	R_X(XYZ)	R_A-R_M	R_x-R_M	$(R_A$-$R_M)$^2 (%%)	$(R_x$-$R_M)$^2 (%%)
30 June 2006	2.941%	2.778%	7.031%	-0.163%	4.090%	0.0266	16.728
31 Dec 2006	7.143%	8.649%	7.445%	1.506%	0.302%	2.268	0.091
30 June 2007	-1.333%	-0.746%	1.359%	0.587%	2.692%	0.345	7.245
31 Dec 2007	5.405%	5.764%	5.699%	0.359%	0.294%	0.129	0.086
30 June 2008	2.564%	1.659%	0.385%	-0.905%	-2.179%	0.819	4.748
31 Dec 2008	1.250%	-0.699%	0.128%	-1.949%	-1.122%	3.799	1.259
30 June 2009	3.704%	3.286%	2.171%	-0.418%	-1.533%	0.175	2.350
31 Dec 2009	-2.381%	1.818%	-0.125%	4.199%	2.256%	17.632	5.089
30 June 2010	2.439%	-0.223%	0.626%	-2.662%	-1.813%	7.086	3.287
31 Dec 2010	8.333%	9.843%	4.975%	1.510%	-3.358%	2.280	11.276
Total				2.064%	-0.371%	34.560	52.159

Relative returns of mutual fund ABC = (2.064%)/10 = 0.2064%

ABC tracking error = ((34.56/10) – (0.2064)^2)^(.5) = 1.847%

ABC information ratio = 0.2064/1.847 = 0.118

Relative returns of mutual fund XYZ = (-0.371%)/10 = -0.037%

ABC tracking error = ((52.159/10) – (-0.037)^2)^(.5) = 2.284%

ABC information ratio = -0.037/2.284 = -0.016

Mutual fund ABC generated positive relative returns as compared to negative relative returns generated by XYZ. ABC also has lower tracking error and a higher information ratio. Therefore, it is advisable for investor to invest in ABC as compared to XYZ.

[Total Marks – 7]

[Total Marks – 100]

****