Q.1 Mr. Garg would have purchased a car from his savings but instead he decided to take car loan from a reputed bank. The bank offered him loan at interest rate of 7% p.a. The same bank was offering fixed deposit at rate of interest 8% p.a. Both car loan and amount put in fixed deposit was Rs. 15 lac. Mr. Garg has three options to repay the car loan. Both car loan and fixed deposit were for a tenure of 5 years and both transactions were made simultaneously. The options;

i. Loan may be repaid at the end of 5 years alongwith interest.

ii. Only interest on car loan may be repaid at the end of each year and loan amount may be repaid at the end of 5 years.

iii. Mr. Garg could have repaid Principal Car Loan and interest thereon by equated yearly instalment. The first such instalment starts at the end of year.

From this information available;

a) Show that in option (i) above, how much amount, Mr. Garg shall repay as principal and interest thereon at the end of 5 years; how the fixed deposit would have grown at the end of 5 years and whether Mr. Garg benefitted by investing money in fixed deposit. If yes, then give Financial and Non Financial benefits of Mr. Garg’s decision.

b) In option (ii), what would be the last instalment to be paid by Mr.Garg at the end of 5 years,

c) In option (iii) what would be equated yearly instalment. Show how Principal amount and interest shall be repaid at the end of each year. Show that in last year, the principal amount is very high as compared to Interest repayment.

d) In case, Mr.Garg approaches the banker at the end 2 years. and repays the loan back, what may be the grievances of Mr.Garg. Do you think these grievances justifiable.

Q.2 i) Define \( q[x] +1 \)  

ii) Explain alongwith with an example what do you understand by nominal rate of interest and effective interest rate

iii) What do you understand by the term ‘GRADUATION’ as regard to Mortality Table.

iv) Using first principles prove \( (\text{Id})_{x:n} = \frac{1}{dx} [S_x - S_{x+n} - nN_{x+n}] \)

v) Why do you think as an FL-81 (Mathematical Basis of Life Assurance) student, that commutation functions are unnecessarily put in exam papers in the light of advanced computers and softwares available these days.
Q.3  
i) Why extras are applied on sub-standard lives. Do Life Insurance Companies keep extra reserve for such sub-standard lives?  
ii) A sub-standard life aged 40 effects an endowment assurance for Rs.10 lac sum assured for a term of 25 years. The office has decided to accept the risk by charging extra premium calculated on basis of rating up of age by 5 years for the first 6 years, by 3 years for next 8 years and by 2 years thereafter. Calculate the extra annual premium. Basis LIC (1970-73) and 6% intt. 
Ignore Expenses. Given;  
\[ P_{40:25} = 0.02148 \]  
\[ \bar{a}_{45:25} = 5.148, \quad \frac{D_{51}}{D_{45}} = 0.67961, \quad \bar{a}_{49:8} = 6.405 \]  
\[ = \frac{D_{57}}{D_{49}} = 0.57843 \]  
\[ \bar{a}_{56:11} = 7.715 \]  

Q.4  
a) Give expressions for the prospective policy value and retrospective policy value at the end of 5 years under an Endowment Assurance policy for a sum assured of Rs.5000/- effected on the life of a person at aged 25 and term of 30 years. Annual premiums under the policy are limited to 15 years. Show that the two expressions are equal. Ignore expenses.  
b) The following particulars are given:  

<table>
<thead>
<tr>
<th>Age 'x'</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
<th>29</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>( l_x )</td>
<td>97380</td>
<td>97088</td>
<td>96794</td>
<td>96496</td>
<td>96194</td>
<td>95887</td>
</tr>
<tr>
<td>( d_x )</td>
<td>292</td>
<td>294</td>
<td>298</td>
<td>302</td>
<td>307</td>
<td>313</td>
</tr>
</tbody>
</table>

Calculate the value of a temporary annuity of Rs.1200/- p.a. for a person aged 26 years for 4 years, the first payment being made immediately.  
(i) Ignoring interest rate  
(ii) Allowing interest of 6% p.a  

Q.5  
i) A person pays Rs. 20,000/- p.a. in advance certainly for 16 years either by him self or his nominee/legal heir and is promised by the financial institution that double of the instalment premium paid shall be paid for next 16 years either to the person himself or to this nominee/legal heir. The first instalment to person/nominee starts at the end of 17 years from now and then at the end of each year. Calculate the return (IRR to Customer)  
ii) What are the risks to the Life Insurance Company (Financial Institution) for bringing such product in the market.  
iii) Do you think that IRDA shall approve such a product, if not, then what may be the considerations before the regulator.  

Q.6  
a) A person now aged 30 has a whole life assurance policy for Rs.15000/- issued to him 10 years ago. He now desires the policy to be altered to an Endowment Assurance Policy for the same sum assured maturing at age 60.  
i) Find the net annual premium under whole life assurance policy.  
ii) Find the revised net annual premium to be payable under Endowment Assurance.
b) Prove mathematically that: 5 each
i) \[ \frac{t}{A_x : \overline{m}} = A_x : \overline{t + m} - A_x : \overline{m} \]
ii) \[ \frac{t}{A_x} = A_x - A_x : \overline{m} \]

Q.7
a) A 12% bond is bought at 120. Show that this price will yield the investor, Mr. Ram Prasad, 10% if and only if the bond is a perpetual bond. 4
b) Given \( 10_{P_{50}} = 0.882, \ 10_{P_{60}^{2}} = 0.729, \ P_{50} = 0.980 \) 2 each
   Calculate the probability that a person aged 50 will die
   i) Before age 70
   ii) Between ages 60 and 70
   iii) In his 61st year.

c) Given that \( a_{x+1:24} = 11.4, \ a_{x:24} = 11.5 \) 6
   \( P_{x} = 0.996, \ q = 0.94 \)
   Calculate annual premium for 25 year temporary assurance to a Life aged \( x \)

d) A Life Insurance Company in India had brought a news in daily news papers that it has benefitted more to its customers who have been loyal to the company. Comment.
   Also list the type of bonuses a life insurance company may declare and how it may allow its customers to use the declared bonuses. 4

Q.8
a) Prove the following expressions by general reasoning: 7
   i) \[ a_{\overline{n}} = \frac{1-q^n}{i} \]
   ii) \[ S_{\overline{n}} = \frac{(1+i)^n - 1}{i} \]

b) Prove the following relationships algebraically: 7
   \[ a_{\overline{n}} = v^n S_{\overline{n}} \]
   \[ S_{n} = (1+i)^n \ a_{\overline{n}} \]

c) A borrower is repaying one debt of Rs.4000/- by 30 equal half-yearly instalments of principal and interest calculated at 9% p.a. convertible half-yearly of which the 12th payment has just been paid and another debt of Rs.1500/- by 20 equal half-yearly instalments of principal and interest calculated at 8% p.a. convertible half-yearly of which the 8th instalment has just been paid.
   If the remaining instalments of the two debts are to be replaced by an annuity certain of 20 half-yearly payments calculated at interest rate of 10% p.a. payable half-yearly, find the instalment of the annuity. 6