MATH 3630 - Actuarial Mathematics I
Fall 2011 - Valdez
Homework No. 5
due Wednesday, 5:00 PM, 16 November 2011

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Name: _____ **Student ID:** _____

I certify that this is my own work, and that I have not copied the work of another student.

Signature: _____ **Date:** _____

Martha is currently age 50 who purchases a deferred whole life annuity-due policy which will pay her the following benefits:

- guaranteed annual payments of \$20,000 for 5 years, starting when she reaches age 65;
- annual payments of \$40,000 for the subsequent 10 years, if alive; and
- annual payments of \$75,000, if alive, thereafter.

You are given:

- Mortality follows the `Standard Ultimate Survival Model`. [see attached]
- $i = 5\%$

Calculate the actuarial present value of Martha's life annuity benefits.

Basic Actuarial Functions based on the Standard Ultimate Model with $i = 5\%$

x	ℓ_x	$1000q_x$	$\ddot{a}_x$	$1000A_x$	$1000\,{}^2A_x$	$1000\,{}_5E_x$	$1000\,{}_{10}E_x$	$1000\,{}_{20}E_x$	x
20	100000.00	0.25	19.9664	49.22	5.80	782.52	612.24	374.40	20
21	99975.04	0.25	19.9197	51.44	6.14	782.50	612.20	374.29	21
22	99949.71	0.26	19.8707	53.78	6.52	782.48	612.15	374.17	22
23	99923.98	0.26	19.8193	56.22	6.94	782.45	612.10	374.04	23
24	99897.79	0.27	19.7655	58.79	7.39	782.43	612.05	373.90	24
25	99871.08	0.27	19.7090	61.47	7.88	782.40	611.98	373.73	25
26	99843.80	0.28	19.6499	64.29	8.41	782.36	611.91	373.54	26
27	99815.86	0.29	19.5878	67.25	9.00	782.33	611.83	373.34	27
28	99787.20	0.30	19.5228	70.34	9.64	782.29	611.74	373.10	28
29	99757.71	0.30	19.4547	73.59	10.33	782.24	611.63	372.84	29
30	99727.29	0.32	19.3834	76.98	11.09	782.19	611.52	372.54	30
31	99695.83	0.33	19.3086	80.54	11.92	782.13	611.39	372.21	31
32	99663.20	0.34	19.2303	84.27	12.81	782.06	611.24	371.83	32
33	99629.26	0.36	19.1484	88.17	13.79	781.99	611.08	371.41	33
34	99593.83	0.37	19.0626	92.26	14.86	781.90	610.90	370.94	34
35	99556.75	0.39	18.9728	96.53	16.01	781.81	610.69	370.41	35
36	99517.80	0.41	18.8788	101.01	17.27	781.70	610.46	369.82	36
37	99476.75	0.44	18.7805	105.69	18.63	781.58	610.20	369.15	37
38	99433.34	0.46	18.6777	110.59	20.12	781.45	609.90	368.41	38
39	99387.29	0.49	18.5701	115.71	21.73	781.30	609.57	367.57	39
40	99338.26	0.53	18.4578	121.06	23.47	781.13	609.20	366.63	40
41	99285.88	0.57	18.3403	126.65	25.36	780.94	608.79	365.58	41
42	99229.76	0.61	18.2176	132.49	27.41	780.72	608.32	364.40	42
43	99169.41	0.66	18.0895	138.59	29.63	780.48	607.80	363.07	43
44	99104.33	0.71	17.9558	144.96	32.03	780.21	607.21	361.59	44
45	99033.94	0.77	17.8162	151.61	34.63	779.91	606.55	359.94	45
46	98957.57	0.84	17.6706	158.54	37.44	779.56	605.81	358.09	46
47	98874.50	0.92	17.5189	165.77	40.47	779.18	604.98	356.01	47
48	98783.91	1.00	17.3607	173.30	43.74	778.75	604.04	353.70	48
49	98684.88	1.10	17.1960	181.14	47.27	778.27	602.99	351.12	49
50	98576.37	1.21	17.0245	189.31	51.08	777.72	601.82	348.24	50
51	98457.24	1.33	16.8461	197.80	55.17	777.11	600.50	345.03	51
52	98326.19	1.47	16.6606	206.64	59.57	776.43	599.02	341.46	52
53	98181.77	1.62	16.4678	215.82	64.30	775.66	597.36	337.49	53
54	98022.38	1.80	16.2676	225.35	69.38	774.79	595.50	333.08	54
55	97846.20	1.99	16.0599	235.24	74.83	773.82	593.42	328.19	55
56	97651.21	2.21	15.8444	245.50	80.67	772.73	591.09	322.79	56
57	97435.17	2.46	15.6212	256.13	86.92	771.51	588.48	316.81	57
58	97195.56	2.74	15.3901	267.14	93.60	770.14	585.56	310.24	58
59	96929.59	3.05	15.1511	278.52	100.73	768.60	582.29	303.00	59

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Standard Ultimate Model

x	ℓ_x	$1000q_x$	$\ddot{a}_x$	$1000A_x$	$1000\,{}^2A_x$	$1000\,{}_5E_x$	$1000\,{}_{10}E_x$	$1000\,{}_{20}E_x$	x
60	96634.14	3.40	14.9041	290.28	108.34	766.87	578.64	295.08	60
61	96305.75	3.79	14.6491	302.43	116.44	764.93	574.57	286.41	61
62	95940.60	4.23	14.3861	314.95	125.06	762.76	570.03	276.98	62
63	95534.43	4.73	14.1151	327.85	134.21	760.33	564.96	266.74	63
64	95082.53	5.29	13.8363	341.13	143.92	757.60	559.32	255.69	64
65	94579.73	5.91	13.5498	354.77	154.20	754.55	553.05	243.81	65
66	94020.33	6.62	13.2557	368.78	165.07	751.14	546.09	231.12	66
67	93398.05	7.41	12.9542	383.13	176.54	747.32	538.36	217.64	67
68	92706.06	8.30	12.6456	397.83	188.62	743.05	529.81	203.43	68
69	91936.88	9.29	12.3302	412.85	201.33	738.28	520.36	188.56	69
70	91082.43	10.41	12.0083	428.18	214.67	732.95	509.94	173.13	70
71	90133.96	11.67	11.6803	443.79	228.64	727.01	498.48	157.30	71
72	89082.09	13.08	11.3468	459.68	243.24	720.39	485.90	141.22	72
73	87916.84	14.66	11.0081	475.80	258.47	713.03	472.15	125.11	73
74	86627.64	16.44	10.6649	492.15	274.33	704.83	457.15	109.18	74
75	85203.46	18.43	10.3178	508.68	290.79	695.74	440.85	93.68	75
76	83632.89	20.67	9.9674	525.36	307.83	685.66	423.23	78.87	76
77	81904.34	23.17	9.6145	542.17	325.44	674.50	404.27	65.00	77
78	80006.23	25.98	9.2598	559.06	343.59	662.17	383.96	52.30	78
79	77927.35	29.13	8.9042	575.99	362.24	648.59	362.35	40.96	79
80	75657.16	32.66	8.5484	592.93	381.34	633.65	339.52	31.13	80
81	73186.31	36.61	8.1934	609.84	400.86	617.27	315.56	22.86	81
82	70507.19	41.03	7.8401	626.66	420.75	599.36	290.64	16.16	82
83	67614.60	45.97	7.4893	643.36	440.94	579.85	264.98	10.94	83
84	64506.50	51.49	7.1421	659.90	461.37	558.68	238.82	7.06	84
85	61184.88	57.66	6.7993	676.22	481.99	535.81	212.50	4.31	85
86	57656.68	64.55	6.4619	692.29	502.72	511.22	186.35	2.48	86
87	53934.73	72.24	6.1308	708.06	523.49	484.92	160.79	1.33	87
88	50038.65	80.80	5.8068	723.49	544.22	456.97	136.21	0.66	88
89	45995.64	90.33	5.4908	738.53	564.84	427.48	113.05	0.30	89
90	41841.05	100.92	5.1835	753.17	585.28	396.59	91.68	0.12	90
91	37618.56	112.68	4.8858	767.35	605.45	364.53	72.44	0.05	91
92	33379.88	125.71	4.5981	781.04	625.29	331.58	55.59	0.02	92
93	29183.78	140.13	4.3213	794.23	644.72	298.08	41.28	0.00	93
94	25094.33	156.05	4.0556	806.88	663.68	264.45	29.55	0.00	94
95	21178.30	173.60	3.8017	818.97	682.09	231.16	20.29	0.00	95
96	17501.76	192.89	3.5597	830.49	699.91	198.72	13.30	0.00	96
97	14125.89	214.03	3.3300	841.43	717.08	167.65	8.27	0.00	97
98	11102.53	237.13	3.1127	851.77	733.56	138.50	4.85	0.00	98
99	8469.73	262.29	2.9079	861.53	749.30	111.73	2.66	0.00	99

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Standard Ultimate Model

x	ℓ_x	$1000q_x$	$\ddot{a}_x$	$1000A_x$	$1000\,{}^{2}A_x$	$1000\,{}_{5}E_x$	$1000\,{}_{10}E_x$	$1000\,{}_{20}E_x$	x
100	6248.17	289.58	2.7156	870.68	764.27	87.77	1.36	0.00	100
101	4438.80	319.05	2.5357	879.25	778.45	66.91	0.64	0.00	101
102	3022.58	350.72	2.3680	887.24	791.82	49.33	0.27	0.00	102
103	1962.49	384.56	2.2124	894.65	804.37	35.01	0.10	0.00	103
104	1207.79	420.50	2.0684	901.50	816.09	23.82	0.04	0.00	104
105	699.91	458.39	1.9359	907.81	826.99	15.45	0.01	0.00	105
106	379.08	498.04	1.8144	913.60	837.07	9.49	0.00	0.00	106
107	190.28	539.14	1.7035	918.88	846.35	5.49	0.00	0.00	107
108	87.69	581.34	1.6029	923.67	854.83	2.97	0.00	0.00	108
109	36.71	624.18	1.5120	928.00	862.55	1.49	0.00	0.00	109
110	13.80	667.11	1.4305	931.88	869.52	0.68	0.00	0.00	110