



CEE 9510 Assignment 3 Answer Key

Question 1

Year	Cash Outlays	Cash Inflow	Discount factor	Discounted Cash Outlays	Discounted Cash inflow	Net Present Value
0	\$ 200,000.00		0	\$(200,000.00)		\$ (200,000.00)
1	\$ 50,000.00		0.869	\$ (43,450.00)		\$ (243,450.00)
2		\$ 50,000.00	0.756		\$ 37,807.00	\$ (205,642.00)
3		\$ 100,000.00	0.657		\$ 65,751.00	\$ (139,890.00)
4		\$ 200,000.00	0.572		\$ 114,351.00	\$ (25,539.00)
5		\$ 75,000.00	0.497		\$ 37,288.00	\$11,749.00

Calculations:

year 0: $(200,000 * (1 / (1 + .03 + .12)^0))$
year 1: $(50,000 * (1 / (1 + .03 + .12)^1))$
year 2: $50,000 * (1 / (1 + .03 + .12)^2)$
year 3: $100,000 * (1 / (1 + .03 + .12)^3)$
year 4: $200,000 * (1 / (1 + .03 + .12)^4)$
year 5: $75,000 * (1 / (1 + .03 + .12)^5)$

The net present value in year 5 is positive. The project should be taken on.

Question 2

@12%

Year	Cash Outlays	Cash Inflow	Discount factor	Discounted Cash Outlays	Discounted Cash inflow	Net Present Value
0	\$ 24,000.00		0	\$ (24,000.00)		\$ (24,000.00)
1		\$ 10,000.00	0.862		\$ 8,620.00	
2		\$ 10,000.00	0.743		\$ 7,430.00	
3		\$ 10,000.00	0.641		\$ 6,410.00	
						\$ (1,540.00)

Calculations:

year 0: $(24,000 * (1 / (1 + .04 + .12)^0))$

year 1: $(10,000 * (1 / (1 + .04 + .12)^1))$

year 2: $(10,000 * (1 / (1 + .04 + .12)^2))$

year 3: $(10,000 * (1 / (1 + .04 + .12)^3))$

The internal rate of return in year 3 is negative. At this rate of return, The project should not be taken on.

@15%

Year	Cash Outlays	Cash Inflow	Discount factor	Discounted Cash Outlays	Discounted Cash inflow	Net Present Value
0	\$ 24,000.00		0	\$ (24,000.00)		\$ (24,000.00)
1		\$ 10,000.00	0.840		\$ 8,400.00	
2		\$ 10,000.00	0.706		\$ 7,060.00	
3		\$ 10,000.00	0.593		\$ 5,930.00	
						\$ (2,610.00)

Calculations:

year 0: $(24,000 * (1 / (1 + .04 + .15)^0))$

year 1: $(10,000 * (1 / (1 + .04 + .15)^1))$

year 2: $(10,000 * (1 / (1 + .04 + .15)^2))$

year 3: $(10,000 * (1 / (1 + .04 + .15)^3))$

The internal rate of return in year 3 is even worse. At this rate of return, The project should not be taken on.

Question 3

Duration (wks)	5	10	15	20	25	30	35	40	45	Wk30 %complete
Design (\$k)	1	7								100
Engineer (\$k)		4	8	8	8					100
Install (\$k)				4	20	6				50
Test (\$k)						2	6	4	2	0
Commission VAV (\$10k)						1.06	2.12	3.00	3.82	10.6
Commission AHU (\$8k)						2.71	2.04	1.72	1.53	33.9
Total (\$k)	1	11	8	12	28	3.77	4.16	4.72	5.35	
Cumulative (\$k)	1	12	20	32	60	63.77	67.93	72.65	78.00	



Y for VAV	0.1
Y for AHU	6
a for VAV	0.5
a for AHU	24
X for VAV	160
X for AHU	4
learn rate	0.75

$$b = \log 0.75 / \log 2 = -.415 \quad \text{learn rate } 0.75$$

$$b = \log 0.5 / \log 2 = -1 \quad \text{learn rate } 0.5$$

VAV

16.08 hours /4 = 4.02 hours per week

17 VAV wk30	17/160 = 10.6% of the draw	10.6%*10000 = \$ 1,060.00
34 VAV wk35	34/160 = 21.2% of the draw	21.2%*10000= \$ 2,120.00
48 VAV wk40	48/160 = 30% of the draw	30.0%*10000= \$ 3,000.00
61 VAV wk45	61/160 = 38% of the draw	38.0%*10000= \$ 3,820.00

AHU

Weekly accomplishment actually goes down for AHUs because the workers stay until they complete one.

24 hrs wk30	24/70.71 = 33.9% of the draw	0.339*8000	\$ 2,712.00
18 hrs wk35	18/70.71 = 25.45% of the draw	0.2545*8000	\$ 2,036.00
15.21 hrs wk40	15.21/70.71 = 21.51% of the draw	0.2151*8000	\$ 1,720.80
13.50 hrs wk45	13.5/70.71= 19.14% of the draw	0.1914*8000	\$ 1,531.20

AHU+VAV 0.75 Learning curve

wk30	1060+2712=	\$ 3,772.00
wk35	2120+2036=	\$ 4,156.00
wk40	3000+1720.80=	\$ 4,720.80
wk45	3800+1531.20=	\$ 5,351.20



Wk 30 Earned Value

1060+0.5*2712= \$ 2,416.00 2.42k

Wk 30 Earned Value no learning curve

2500+0.5*2000= \$ 3,000.00

Savings to University in wk 30

No Curve 2500+2000= \$ 4,500.00

learning curve \$ 3,772.00

Savings is Difference \$ 728.00

Learning curve of 0.5

VAV

2.83/4=	0.7075 hrs per week		
2 VAV wk 30	2/160 = 1.25% of draw	as above	\$ 125.00
8 VAV wk 35	8/160 = 5.00% of draw		\$ 500.00
33 VAV wk 40	33/160 = 20.63% of draw		\$ 2,063.00
117 VAV wk 45	117/160 = 73.12% of draw		\$ 7,312.00

AHU

24/50=	48% in wk 30	.48*8000	\$ 3,840.00
12/50=	24% in wk 35	.24*8000	\$ 1,920.00
8/50=	16% in wk 40	.16*8000	\$ 1,280.00
6/50=	12% in wk 45	.12*8000	\$ 960.00

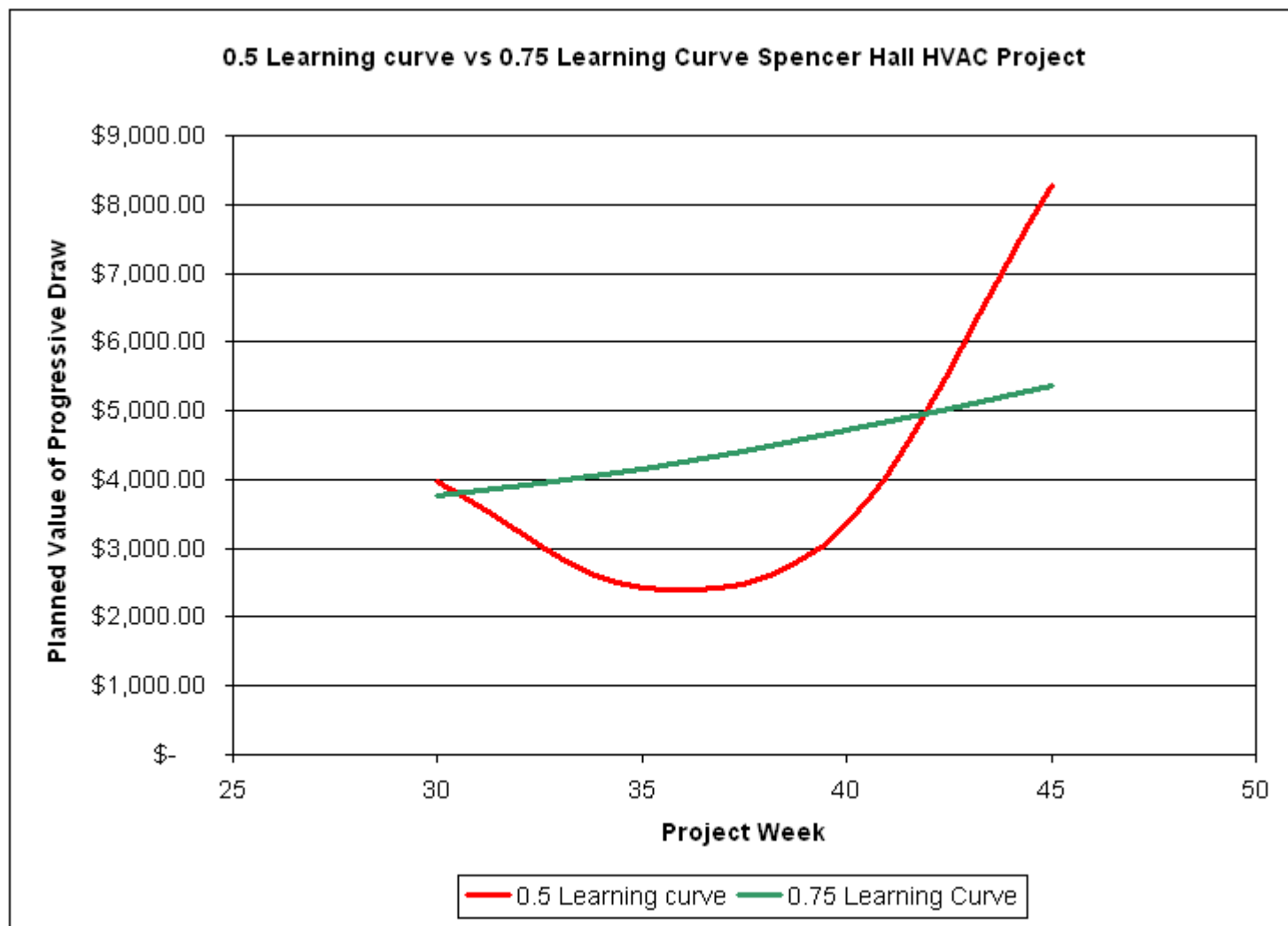
wk 30 total with learning curve 0.5 = 3840+ 125 = \$ 3,965.00

No curve 2500+2000 \$ 4,500.00

Savings is difference no curve - .5 curve \$ 535.00

AHU + VAV 0.5 Learning Curve

wk30	\$3,965.00
wk35	\$2,420.00
wk40	\$3,343.00
wk45	\$8,272.00





VAV Boxes 0.75 LC

X	X ^a b	Y _x
1	1.00	0.50
2	0.75	0.38
3	0.63	0.32
4	0.56	0.28
5	0.51	0.26
6	0.48	0.24
7	0.45	0.22
8	0.42	0.21
9	0.40	0.20
10	0.38	0.19
11	0.37	0.18
12	0.36	0.18
13	0.34	0.17
14	0.33	0.17
15	0.33	0.16
16	0.32	0.16
17	0.31	0.15
18	0.30	0.15
19	0.29	0.15
20	0.29	0.14
21	0.28	0.14
22	0.28	0.14
23	0.27	0.14
24	0.27	0.13
25	0.26	0.13
26	0.26	0.13
27	0.25	0.13
28	0.25	0.13
29	0.25	0.12
30	0.24	0.12
31	0.24	0.12
32	0.24	0.12
33	0.23	0.12

AHUs 0.75 LC

X	X ^a b	Y _x
1	1.00	24.00
2	0.75	18.00
3	0.63	15.21
4	0.56	13.50
		70.71

VAV Boxes 0.5 LC

X	X ^a b	Y _x
1	1.00	0.500
2	0.50	0.250
3	0.33	0.167
4	0.25	0.125
5	0.20	0.100
6	0.17	0.083
7	0.14	0.071
8	0.13	0.063
9	0.11	0.056
10	0.10	0.050
11	0.09	0.045
12	0.08	0.042
13	0.08	0.038
14	0.07	0.036
15	0.07	0.033
16	0.06	0.031
17	0.06	0.029
18	0.06	0.028
19	0.05	0.026
20	0.05	0.025
21	0.05	0.024
22	0.05	0.023
23	0.04	0.022
24	0.04	0.021
25	0.04	0.020
26	0.04	0.019
27	0.04	0.019
28	0.04	0.018
29	0.03	0.017
30	0.03	0.017
31	0.03	0.016
32	0.03	0.016
33	0.03	0.015

AHUs 0.5 LC

X	X ^a b	Y _x
1	1.00	24.00
2	0.50	12.00
3	0.33	8.00
4	0.25	6.00
		50.00



33	0.23	0.12
34	0.23	0.12
35	0.23	0.11
36	0.23	0.11
37	0.22	0.11
38	0.22	0.11
39	0.22	0.11
40	0.22	0.11
41	0.21	0.11
42	0.21	0.11
43	0.21	0.10
44	0.21	0.10
45	0.21	0.10
46	0.20	0.10
47	0.20	0.10
48	0.20	0.10
49	0.20	0.10
50	0.20	0.10
51	0.20	0.10
52	0.19	0.10
53	0.19	0.10
54	0.19	0.10
55	0.19	0.09
56	0.19	0.09
57	0.19	0.09
58	0.19	0.09
59	0.18	0.09
60	0.18	0.09
61	0.18	0.09
62	0.18	0.09
63	0.18	0.09
64	0.18	0.09
65	0.18	0.09
66	0.18	0.09
67	0.17	0.09
68	0.17	0.09
69	0.17	0.09

33	0.03	0.015
34	0.03	0.015
35	0.03	0.014
36	0.03	0.014
37	0.03	0.014
38	0.03	0.013
39	0.03	0.013
40	0.03	0.013
41	0.02	0.012
42	0.02	0.012
43	0.02	0.012
44	0.02	0.011
45	0.02	0.011
46	0.02	0.011
47	0.02	0.011
48	0.02	0.010
49	0.02	0.010
50	0.02	0.010
51	0.02	0.010
52	0.02	0.010
53	0.02	0.009
54	0.02	0.009
55	0.02	0.009
56	0.02	0.009
57	0.02	0.009
58	0.02	0.009
59	0.02	0.008
60	0.02	0.008
61	0.02	0.008
62	0.02	0.008
63	0.02	0.008
64	0.02	0.008
65	0.02	0.008
66	0.02	0.008
67	0.01	0.007
68	0.01	0.007
69	0.01	0.007



70	0.17	0.09
71	0.17	0.09
72	0.17	0.08
73	0.17	0.08
74	0.17	0.08
75	0.17	0.08
76	0.17	0.08
77	0.16	0.08
78	0.16	0.08
79	0.16	0.08
80	0.16	0.08
81	0.16	0.08
82	0.16	0.08
83	0.16	0.08
84	0.16	0.08
85	0.16	0.08
86	0.16	0.08
87	0.16	0.08
88	0.16	0.08
89	0.16	0.08
90	0.15	0.08
91	0.15	0.08
92	0.15	0.08
93	0.15	0.08
94	0.15	0.08
95	0.15	0.08
96	0.15	0.08
97	0.15	0.07
98	0.15	0.07
99	0.15	0.07
100	0.15	0.07
101	0.15	0.07
102	0.15	0.07
103	0.15	0.07
104	0.15	0.07
105	0.14	0.07

70	0.01	0.007
71	0.01	0.007
72	0.01	0.007
73	0.01	0.007
74	0.01	0.007
75	0.01	0.007
76	0.01	0.007
77	0.01	0.006
78	0.01	0.006
79	0.01	0.006
80	0.01	0.006
81	0.01	0.006
82	0.01	0.006
83	0.01	0.006
84	0.01	0.006
85	0.01	0.006
86	0.01	0.006
87	0.01	0.006
88	0.01	0.006
89	0.01	0.006
90	0.01	0.006
91	0.01	0.005
92	0.01	0.005
93	0.01	0.005
94	0.01	0.005
95	0.01	0.005
96	0.01	0.005
97	0.01	0.005
98	0.01	0.005
99	0.01	0.005
100	0.01	0.005
101	0.01	0.005
102	0.01	0.005
103	0.01	0.005
104	0.01	0.005
105	0.01	0.005



106	0.14	0.07
107	0.14	0.07
108	0.14	0.07
109	0.14	0.07
110	0.14	0.07
111	0.14	0.07
112	0.14	0.07
113	0.14	0.07
114	0.14	0.07
115	0.14	0.07
116	0.14	0.07
117	0.14	0.07
118	0.14	0.07
119	0.14	0.07
120	0.14	0.07
121	0.14	0.07
122	0.14	0.07
123	0.14	0.07
124	0.14	0.07
125	0.13	0.07
126	0.13	0.07
127	0.13	0.07
128	0.13	0.07
129	0.13	0.07
130	0.13	0.07
131	0.13	0.07
132	0.13	0.07
133	0.13	0.07
134	0.13	0.07
135	0.13	0.07
136	0.13	0.07
137	0.13	0.06
138	0.13	0.06
139	0.13	0.06
140	0.13	0.06
141	0.13	0.06
142	0.13	0.06

106	0.01	0.005
107	0.01	0.005
108	0.01	0.005
109	0.01	0.005
110	0.01	0.005
111	0.01	0.005
112	0.01	0.004
113	0.01	0.004
114	0.01	0.004
115	0.01	0.004
116	0.01	0.004
117	0.01	0.004
118	0.01	0.004
119	0.01	0.004
120	0.01	0.004
121	0.01	0.004
122	0.01	0.004
123	0.01	0.004
124	0.01	0.004
125	0.01	0.004
126	0.01	0.004
127	0.01	0.004
128	0.01	0.004
129	0.01	0.004
130	0.01	0.004
131	0.01	0.004
132	0.01	0.004
133	0.01	0.004
134	0.01	0.004
135	0.01	0.004
136	0.01	0.004
137	0.01	0.004
138	0.01	0.004
139	0.01	0.004
140	0.01	0.004
141	0.01	0.004
142	0.01	0.004

143	0.13	0.06
144	0.13	0.06
145	0.13	0.06
146	0.13	0.06
147	0.13	0.06
148	0.13	0.06
149	0.13	0.06
150	0.13	0.06
151	0.12	0.06
152	0.12	0.06
153	0.12	0.06
154	0.12	0.06
155	0.12	0.06
156	0.12	0.06
157	0.12	0.06
158	0.12	0.06
159	0.12	0.06
160	0.12	0.06
		16.08

143	0.01	0.003
144	0.01	0.003
145	0.01	0.003
146	0.01	0.003
147	0.01	0.003
148	0.01	0.003
149	0.01	0.003
150	0.01	0.003
151	0.01	0.003
152	0.01	0.003
153	0.01	0.003
154	0.01	0.003
155	0.01	0.003
156	0.01	0.003
157	0.01	0.003
158	0.01	0.003
159	0.01	0.003
160	0.01	0.003
		2.83