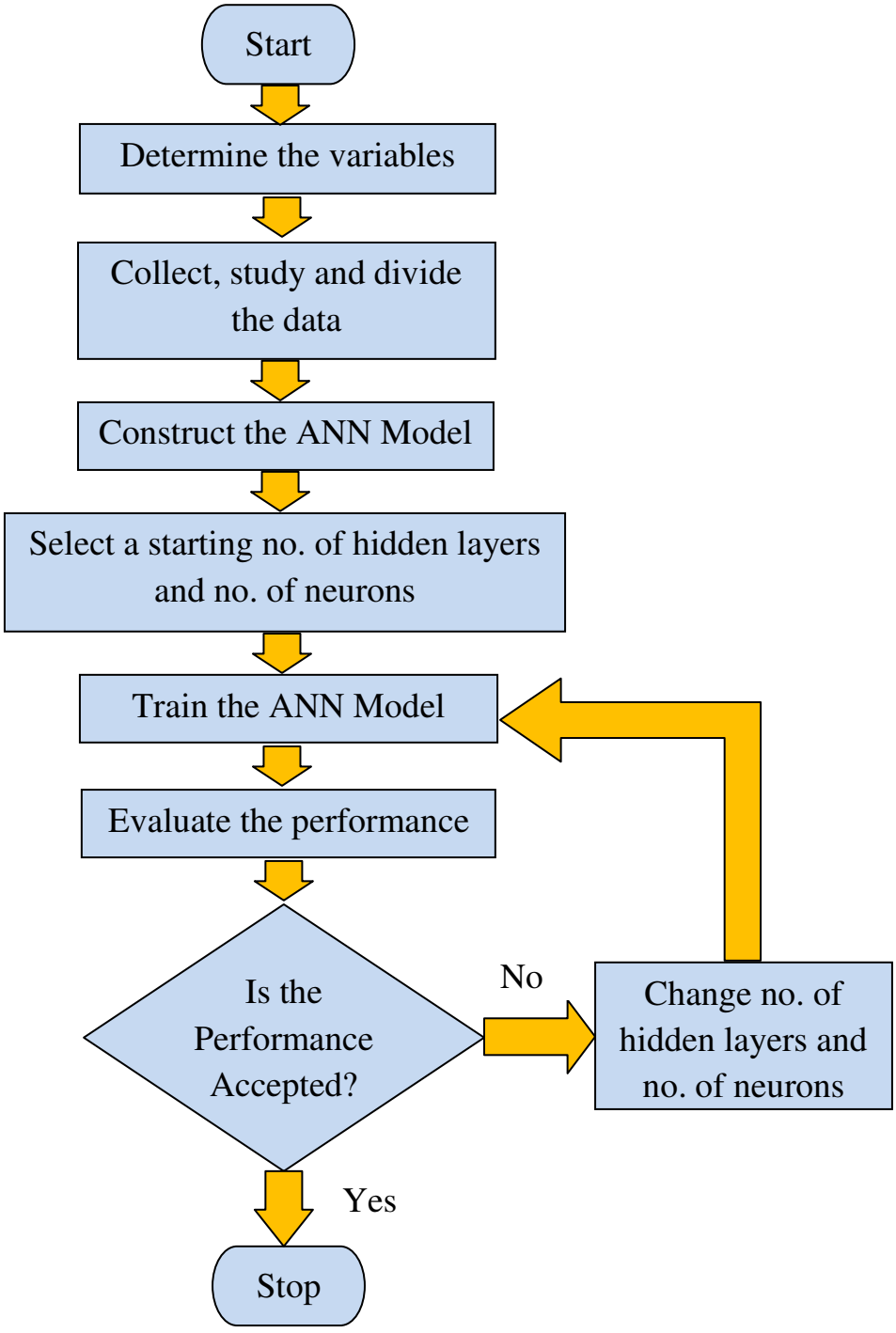
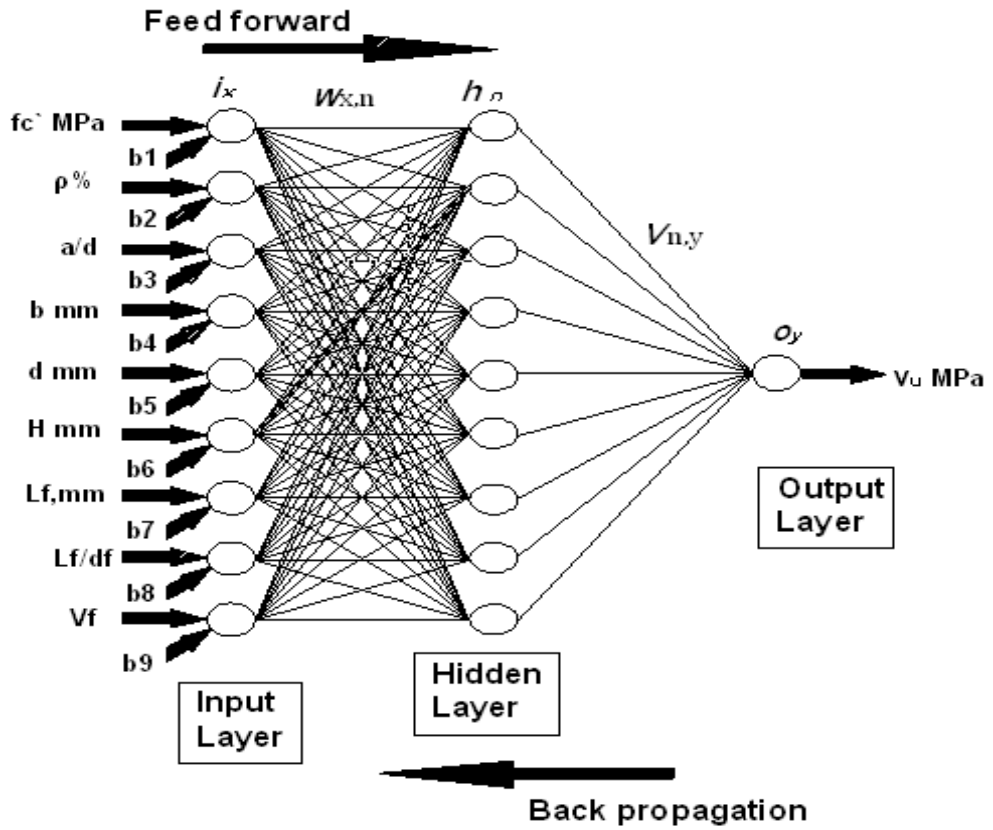
APPENDICES

Appendix A: Developing Process 'flow chart' for a Neural Network Forecasting Model.



Appendix B: Artificial Neural Network Model: Architecture, Weights and Biases.



Weight	Wi1	Wi2	Wi3	Wi4	Wi5	Wi6	Wi7	Wi8	Wi9	Vi1	Bias(b)
W1j	-0.785	-4.761	4.378	47.477	4.143	-5.339	-0.523	2.618	-2.032	-3.740	-0.791
W2j	-5.665	-0.539	-2.828	-31.262	-1.288	15.848	-6.374	-2.087	0.354	-0.459	5.758
W3j	-0.108	2.549	7.163	27.226	5.655	-18.061	-0.551	-1.855	-0.495	0.806	5.434
W4j	-2.344	-32.703	-13.649	65.378	20.847	0.432	3.837	-21.889	-4.532	0.125	-7.209
W5j	3.782	44.923	13.639	-86.024	-19.760	-1.008	-1.811	22.522	2.705	-0.887	3.752
W6j	3.195	-18.153	-14.798	-6.160	-12.883	-1.399	3.936	4.155	0.239	0.188	-6.877
W7j	1.729	6.899	-3.742	-1.928	-3.027	-12.706	1.572	7.656	0.209	3.517	-0.715
W8j	1.261	-1.393	-3.947	10.892	-2.926	10.807	1.029	-0.217	3.163	-0.736	-1.445
W9j	2.182	-2.153	0.470	15.576	0.565	13.671	2.596	2.176	-0.081	1.741	1.916

Appendix C: Training Data.

S/N	Fiber properties			Section properties			Beam properties			Exp.	Prediction				
	Vf	Lf/df	Lf, mm	H, mm	d, mm	b, mm	a/d	ρ, %	fc'	Vu MPa	Vu MPa	MSE	MAE	Pre/Exp	Error %
1	0.00	0.00	0.00	250	212	125	2	1.51	62.6	3.02	3.0286	0.0001	0.01	1.00	0.28
2	0.00	0.00	0.00	250	212	125	3	1.51	62.6	2.53	2.5617	0.0010	0.03	1.01	1.25
3	0.50	63.00	50.00	250	212	125	3	1.51	63.8	3.09	3.0722	0.0003	0.02	0.99	(0.58)
4	0.75	63.00	50.00	250	212	125	3	1.51	68.6	3.40	3.4445	0.0020	0.04	1.01	1.31
5	0.00	0.00	0.00	250	212	125	4	1.51	62.6	1.98	1.9466	0.0011	0.03	0.98	(1.69)
6	0.50	63.00	50.00	250	212	125	4	1.51	63.8	2.41	2.3802	0.0009	0.03	0.99	(1.24)
7	0.75	63.00	50.00	250	212	125	4	1.51	68.6	2.74	2.7584	0.0003	0.02	1.01	0.67
8	0.50	63.00	50.00	250	212	125	2	1.51	30.8	4.04	4.0472	0.0001	0.01	1.00	0.18
9	0.50	63.00	50.00	250	212	125	3	1.51	30.8	2.55	2.5432	0.0000	0.01	1.00	(0.27)
10	0.50	63.00	50.00	250	212	125	4	1.51	30.8	2.00	1.9964	0.0000	0.00	1.00	(0.18)
11	1.00	60.00	30.00	457	381	152	3.5	1.96	38.1	3.03	3.0340	0.0000	0.00	1.00	0.13
12	1.00	60.00	30.00	457	381	152	3.5	1.96	38.1	3.09	3.0340	0.0031	0.06	0.98	(1.81)
13	1.00	60.00	30.00	457	381	152	3.5	2.67	38.1	3.46	3.4960	0.0013	0.04	1.01	1.04
14	0.00	0.00	0.00	457	381	152	3.4	2.67	42.8	1.12	1.1152	0.0000	0.00	1.00	(0.43)
15	0.00	0.00	0.00	457	381	152	3.4	2.67	42.8	1.08	1.1152	0.0012	0.04	1.03	3.25
16	1.50	60.00	30.00	457	381	152	3.4	2.67	31	2.56	2.9723	0.1700	0.41	1.16	16.10
17	1.50	60.00	30.00	457	381	152	3.4	2.67	31	3.37	2.9723	0.1582	0.40	0.88	(11.80)
18	1.50	60.00	30.00	457	381	152	3.4	2.67	44.9	3.28	3.2731	0.0000	0.01	1.00	(0.21)
19	1.50	60.00	30.00	457	381	152	3.4	2.67	44.9	3.26	3.2731	0.0002	0.01	1.00	0.40

20	1.00	80.00	60.00	457	381	152	3.4	2.67	49.2	2.97	3.3706	0.1605	**0.40**	**1.13**	**13.49**
21	1.00	80.00	60.00	457	381	152	3.4	2.67	49.2	3.77	3.3706	0.1595	**0.40**	**0.89**	**(10.59)**
22	0.00	0.00	0.00	610	558	152	1.6	2.22	60	1.75	1.5790	0.0292	**0.17**	**0.90**	**(9.77)**
23	0.70	60.00	30.00	610	558	152	1.6	2.22	54.1	3.24	3.3044	0.0041	**0.06**	**1.02**	**1.99**
24	1.50	60.00	30.00	610	558	152	1.6	2.22	49.9	3.81	3.7997	0.0001	**0.01**	**1.00**	**(0.27)**
25	0.00	0.00	0.00	610	558	152	1.6	2.22	57	1.43	1.6122	0.0332	**0.18**	**1.13**	**12.74**
26	0.40	60.00	30.00	610	558	152	1.6	2.22	54.8	2.40	2.4066	0.0000	**0.01**	**1.00**	**0.27**
27	0.60	60.00	30.00	610	558	152	1.6	2.22	56.5	2.73	2.6674	0.0039	**0.06**	**0.98**	**(2.29)**
28	0.40	100.00	50.00	610	558	152	1.6	2.22	46.9	2.90	2.9052	0.0000	**0.01**	**1.00**	**0.18**
29	0.60	100.00	50.00	610	558	152	1.6	2.22	40.8	2.79	2.7917	0.0000	**0.00**	**1.00**	**0.06**
30	0.00	0.00	0.00	250	219	150	2.79	1.92	41.2	1.23	1.3219	0.0084	**0.09**	**1.07**	**7.47**
31	1.00	60.00	30.00	250	219	150	2.79	1.92	40.9	2.93	2.8301	0.0100	**0.10**	**0.97**	**(3.41)**
32	2.00	60.00	30.00	250	219	150	2.79	1.92	43.2	3.14	3.1589	0.0004	**0.02**	**1.01**	**0.60**
33	0.00	0.00	0.00	250	219	150	2	1.92	41.2	1.51	1.5359	0.0007	**0.03**	**1.02**	**1.72**
34	1.00	60.00	30.00	250	219	150	2	1.92	40.9	3.50	3.4975	0.0000	**0.00**	**1.00**	**(0.07)**
35	2.00	60.00	30.00	250	219	150	2	1.92	43.2	3.52	3.4992	0.0004	**0.02**	**0.99**	**(0.59)**
36	0.00	0.00	0.00	250	212	125	2	1.48	62.6	3.02	3.0320	0.0001	**0.01**	**1.00**	**0.40**
37	0.00	0.00	0.00	250	212	125	3	1.48	62.6	2.53	2.4930	0.0014	**0.04**	**0.99**	**(1.46)**
38	0.50	63.00	50.00	250	212	125	3	1.48	63.8	3.09	3.0681	0.0005	**0.02**	**0.99**	**(0.71)**
39	0.75	63.00	50.00	250	212	125	3	1.48	68.6	3.40	3.4294	0.0009	**0.03**	**1.01**	**0.87**
40	0.00	0.00	0.00	250	212	125	4	1.48	62.6	1.98	1.9227	0.0033	**0.06**	**0.97**	**(2.89)**
41	0.50	63.00	50.00	250	212	125	4	1.48	63.8	2.41	2.3902	0.0004	**0.02**	**0.99**	**(0.82)**
42	0.75	63.00	50.00	250	212	125	4	1.48	68.6	2.74	2.7551	0.0002	**0.02**	**1.01**	

															0.55
43	0.50	63.00	50.00	250	212	125	2	1.48	30.8	4.04	4.0338	0.0000	0.01	1.00	(0.15)
44	0.50	63.00	50.00	250	212	125	3	1.48	30.8	2.55	2.5241	0.0007	0.03	0.99	(1.02)
45	0.50	63.00	50.00	250	212	125	4	1.48	30.8	2.00	1.9905	0.0001	0.01	1.00	(0.48)
46	0.00	0.00	0.00	228	204	127	3	2.20	17.8	1.63	1.6062	0.0006	0.02	0.99	(1.46)
47	0.00	0.00	0.00	127	102	63.5	1	1.10	17.8	4.79	4.7111	0.0062	0.08	0.98	(1.65)
48	0.00	0.00	0.00	127	102	63.5	2	1.10	17.8	3.14	3.1701	0.0009	0.03	1.01	0.96
49	0.00	0.00	0.00	127	102	63.5	3	1.10	17.8	1.55	1.5373	0.0002	0.01	0.99	(0.82)
50	0.00	0.00	0.00	127	102	63.5	1	2.20	17.8	4.54	4.6298	0.0081	0.09	1.02	1.98
51	0.00	0.00	0.00	127	102	63.5	2	2.20	17.8	2.64	2.6319	0.0001	0.01	1.00	(0.31)
52	0.00	0.00	0.00	127	102	63.5	3	2.20	17.8	1.65	1.6497	0.0000	0.00	1.00	(0.02)
53	0.00	0.00	0.00	127	102	63.5	1.5	1.10	17.8	4.46	4.4353	0.0006	0.02	0.99	(0.55)
54	1.00	60.00	30.00	228	204	127	3	2.20	22.7	3.05	3.1105	0.0037	0.06	1.02	1.98
55	1.00	60.00	30.00	127	102	63.5	3	2.20	22.7	3.16	3.0828	0.0060	0.08	0.98	(2.44)
56	1.00	60.00	30.00	127	102	63.5	3	1.10	22.7	2.43	2.4605	0.0009	0.03	1.01	1.25
57	1.00	100.00	50.00	228	204	127	3	2.20	26	3.05	3.0015	0.0024	0.05	0.98	(1.59)
58	1.00	100.00	50.00	127	102	63.5	3	2.20	26	3.55	3.5864	0.0013	0.04	1.01	1.03
59	0.50	60.00	30.00	254	221	152	1.5	1.19	34	3.17	3.1533	0.0003	0.02	0.99	(0.53)
60	0.50	60.00	30.00	254	221	152	2.5	1.19	34	1.72	1.7175	0.0000	0.00	1.00	(0.15)
61	0.50	60.00	30.00	254	221	152	3.5	1.19	34	1.34	1.3990	0.0035	0.06	1.04	4.41
62	0.00	0.00	0.00	254	221	152	1.5	1.19	34	1.93	1.9685	0.0015	0.04	1.02	2.00
63	0.00	0.00	0.00	254	221	152	3.5	1.19	34	1.17	1.1655	0.0000	0.00	1.00	(0.39)
64	1.00	60.00	30.00	254	221	152	1.5	1.19	34	3.16	3.1671	0.0001	0.01	1.00	0.22

65	1.00	60.00	30.00	254	221	152	2.5	1.19	34	1.79	1.8429	0.0028	**0.05**	**1.03**	**2.95**
66	1.00	60.00	30.00	254	221	152	3.5	1.19	34	1.38	1.4806	0.0101	**0.10**	**1.07**	**7.29**
67	0.50	60.00	30.00	254	221	152	1.5	2.39	34	4.00	4.0115	0.0001	**0.01**	**1.00**	**0.29**
68	0.50	60.00	30.00	254	221	152	2.5	2.39	34	1.89	1.7966	0.0087	**0.09**	**0.95**	**(4.94)**
69	0.50	60.00	30.00	254	221	152	3.5	2.39	34	1.47	1.4751	0.0000	**0.01**	**1.00**	**0.35**
70	0.00	0.00	0.00	254	221	152	1.5	2.39	34	2.37	2.3486	0.0005	**0.02**	**0.99**	**(0.90)**
71	0.00	0.00	0.00	254	221	152	3.5	2.39	34	1.03	1.3441	0.0987	**0.31**	**1.30**	**30.50**
72	1.00	60.00	30.00	254	221	152	1.5	2.39	34	4.38	4.3930	0.0002	**0.01**	**1.00**	**0.30**
73	1.00	60.00	30.00	254	221	152	2.5	2.39	34	2.45	2.3694	0.0065	**0.08**	**0.97**	**(3.29)**
74	1.00	60.00	30.00	254	221	152	3.5	2.39	34	2.00	2.0409	0.0017	**0.04**	**1.02**	**2.05**
75	0.00	0.00	0.00	229	197	152	2	1.34	24.2	2.00	1.9283	0.0051	**0.07**	**0.96**	**(3.58)**
76	0.00	0.00	0.00	229	197	152	2.8	1.34	24.2	1.50	1.5002	0.0000	**0.00**	**1.00**	**0.01**
77	0.00	0.00	0.00	229	197	152	3.6	1.34	24.2	1.28	1.3385	0.0034	**0.06**	**1.05**	**4.57**
78	0.00	0.00	0.00	229	197	152	4.4	1.34	24.2	1.12	1.2708	0.0227	**0.15**	**1.13**	**13.46**
79	0.50	60.00	30.00	229	197	152	2	1.34	29.1	2.50	2.4576	0.0018	**0.04**	**0.98**	**(1.70)**
80	0.50	60.00	30.00	229	197	152	2.8	1.34	29.1	1.75	1.6954	0.0030	**0.05**	**0.97**	**(3.12)**
81	0.50	60.00	30.00	229	197	152	3.6	1.34	29.1	1.50	1.5526	0.0028	**0.05**	**1.04**	**3.51**
82	0.50	60.00	30.00	229	197	152	4.4	1.34	29.1	1.26	1.2493	0.0001	**0.01**	**0.99**	**(0.85)**
83	0.75	60.00	30.00	229	197	152	2	1.34	29.9	2.83	2.9245	0.0089	**0.09**	**1.03**	**3.34**
84	0.75	60.00	30.00	229	197	152	2.8	1.34	29.9	2.00	2.1435	0.0206	**0.14**	**1.07**	**7.17**
85	0.75	60.00	30.00	229	197	152	3.6	1.34	29.9	1.58	1.6118	0.0010	**0.03**	**1.02**	**2.01**
86	0.75	60.00	30.00	229	197	152	4.4	1.34	29.9	1.36	1.3809	0.0004	**0.02**	**1.02**	**1.54**
87	0.75	60.00	30.00	229	200	152	2.8	0.79	29.9	1.23	1.2794	0.0024	**0.05**	**1.04**	

															4.02
88	0.75	60.00	30.00	229	197	152	2.8	2.00	29.9	2.16	2.3473	0.0351	0.19	1.09	8.67
89	1.00	60.00	30.00	229	197	152	2	1.34	30	3.09	3.0311	0.0035	0.06	0.98	(1.91)
90	1.00	60.00	30.00	229	197	152	2.8	1.34	30	2.16	2.1716	0.0001	0.01	1.01	0.53
91	1.00	60.00	30.00	229	197	152	3.6	1.34	30	1.68	1.6270	0.0028	0.05	0.97	(3.16)
92	1.00	60.00	30.00	229	197	152	4.4	1.34	30	1.46	1.3936	0.0044	0.07	0.95	(4.55)
93	1.00	60.00	30.00	229	200	152	2.8	0.79	20.6	1.15	1.1029	0.0022	0.05	0.96	(4.09)
94	0.75	60.00	30.00	229	197	152	2.8	1.34	20.6	1.50	1.5251	0.0006	0.03	1.02	1.67
95	0.75	60.00	30.00	229	197	152	2.8	2.00	20.6	2.00	1.8756	0.0155	0.12	0.94	(6.22)
96	0.75	60.00	30.00	229	200	152	2.8	0.79	33.4	1.53	1.4627	0.0045	0.07	0.96	(4.40)
97	0.75	60.00	30.00	229	197	152	2.8	1.34	33.4	2.50	2.3784	0.0148	0.12	0.95	(4.86)
98	1.00	50.00	30.00	250	195	200	3.1	3.10	44.8	4.85	4.7551	0.0090	0.09	0.98	(1.96)
99	0.75	86.00	60.00	500	410	200	2.9	3.00	68.4	4.13	4.1316	0.0000	0.00	1.00	0.04
100	0.00	0.00	0.00	300	260	200	3.5	3.56	44	1.74	1.7413	0.0000	0.00	1.00	0.07
101	0.25	67.00	60.00	300	260	200	3.5	3.56	46.9	2.11	2.2145	0.0109	0.10	1.05	4.95
102	0.51	67.00	60.00	300	260	200	3.5	3.56	43.7	2.31	2.3040	0.0000	0.01	1.00	(0.26)
103	0.76	67.00	60.00	300	260	200	3.5	3.56	48.3	2.98	2.9236	0.0032	0.06	0.98	(1.89)
104	0.00	0.00	0.00	300	260	200	1.5	1.81	40.8	4.03	4.0564	0.0007	0.03	1.01	0.65
105	0.00	0.00	0.00	300	262	200	2.5	1.15	40.1	1.50	1.5148	0.0002	0.01	1.01	0.99
106	0.25	67.00	60.00	300	262	200	2.5	1.15	40	1.57	1.5348	0.0012	0.04	0.98	(2.24)
107	0.76	67.00	60.00	300	262	200	2.5	1.15	38.7	2.06	2.0341	0.0007	0.03	0.99	(1.26)
108	0.00	0.00	0.00	300	260	200	2.5	1.81	40.1	2.30	2.2767	0.0005	0.02	0.99	(1.01)
109	0.25	67.00	60.00	300	260	200	2.5	1.81	40	2.07	2.1130	0.0018	0.04	1.02	2.08

110	0.76	67.00	60.00	300	260	200	2.5	1.81	38.7	2.77	2.8090	0.0015	**0.04**	**1.01**	**1.41**
111	0.00	0.00	0.00	300	260	200	4	1.81	40.8	1.44	1.2397	0.0401	**0.20**	**0.86**	**(13.91)**
112	0.25	67.00	60.00	300	260	200	4	1.81	41.2	1.58	1.5757	0.0000	**0.00**	**1.00**	**(0.27)**
113	0.76	67.00	60.00	300	260	200	4	1.81	40.3	2.25	2.2621	0.0001	**0.01**	**1.01**	**0.54**
114	0.00	0.00	0.00	300	260	200	3.5	2.83	32.1	1.15	1.3820	0.0538	**0.23**	**1.20**	**20.17**
115	0.50	67.00	60.00	300	260	200	3.5	2.83	37.7	2.13	2.2593	0.0167	**0.13**	**1.06**	**6.07**
116	0.50	67.00	60.00	450	410	200	3.3	3.08	37.7	1.77	1.8067	0.0013	**0.04**	**1.02**	**2.08**
117	0.00	0.00	0.00	600	540	200	3.5	2.73	32.1	1.00	1.0862	0.0074	**0.09**	**1.09**	**8.62**
118	0.50	67.00	60.00	600	540	200	3.5	2.73	37.7	1.42	1.4049	0.0002	**0.02**	**0.99**	**(1.06)**
119	0.00	0.00	0.00	500	460	200	3.4	2.80	32.1	1.65	1.2556	0.1556	**0.39**	**0.76**	**(23.91)**
120	0.50	67.00	60.00	300	260	200	3.5	2.83	38.8	2.53	2.3353	0.0379	**0.19**	**0.92**	**(7.70)**
121	0.50	67.00	60.00	500	460	200	3.4	2.41	38.8	1.61	1.6544	0.0020	**0.04**	**1.03**	**2.76**
122	0.50	67.00	60.00	500	460	200	3.4	2.80	38.8	1.78	1.7003	0.0064	**0.08**	**0.96**	**(4.48)**
123	0.00	0.00	0.00	610	546	305	2.8	1.84	39.4	1.16	1.1607	0.0000	**0.00**	**1.00**	**0.06**
124	0.50	80.00	76.00	610	546	305	2.8	1.84	33.7	1.40	1.4201	0.0004	**0.02**	**1.01**	**1.43**
125	1.00	80.00	76.00	610	546	305	2.8	1.84	31.5	1.72	1.7102	0.0001	**0.01**	**0.99**	**(0.57)**
126	1.50	80.00	76.00	610	546	305	2.8	1.84	32.8	2.03	2.0326	0.0000	**0.00**	**1.00**	**0.13**
127	0.00	0.00	0.00	305	276	150	1.8	1.44	42.3	1.53	1.5435	0.0002	**0.01**	**1.01**	**0.88**
128	0.00	0.00	0.00	305	276	150	1.8	2.99	43.2	2.74	2.7226	0.0003	**0.02**	**0.99**	**(0.64)**
129	0.90	83.00	51.00	305	276	150	1.8	4.54	48.6	2.94	2.9640	0.0006	**0.02**	**1.01**	**0.81**
130	0.00	0.00	0.00	250	210	175	4.5	4.00	38	1.77	1.7782	0.0001	**0.01**	**1.00**	**0.47**
131	0.40	100.00	50.00	250	210	175	4.5	4.00	35.5	2.16	2.1545	0.0000	**0.01**	**1.00**	**(0.26)**
132	0.80	100.00	50.00	250	210	175	4.5	4.00	37.4	3.10	3.0857	0.0002	**0.01**	**1.00**	

															(0.46)
133	1.20	100.00	50.00	250	210	175	4.5	4.00	39.8	3.13	3.1564	0.0007	0.03	1.01	0.84
134	0.80	100.00	50.00	250	210	175	4.5	3.05	38.2	3.21	3.2191	0.0001	0.01	1.00	0.28
135	0.80	100.00	50.00	250	210	175	4.5	1.95	41.8	2.62	2.5823	0.0014	0.04	0.99	(1.44)
136	0.00	0.00	0.00	250	210	175	4.5	1.95	43	1.57	1.2868	0.0802	0.28	0.82	(18.04)
137	0.80	100.00	50.00	250	210	175	4.5	1.95	35.1	2.05	2.0809	0.0010	0.03	1.02	1.51
138	0.00	0.00	0.00	300	265	55	2	4.31	35.4	3.37	3.3658	0.0000	0.00	1.00	(0.12)
139	0.00	0.00	0.00	300	265	55	3.4	4.31	33.6	1.30	1.3048	0.0000	0.00	1.00	0.37
140	1.00	100.00	50.00	300	265	55	3.4	4.31	40.9	4.03	3.9798	0.0025	0.05	0.99	(1.25)
141	0.00	0.00	0.00	300	265	55	4.9	4.31	34.1	1.19	1.2006	0.0001	0.01	1.01	0.89
142	1.00	100.00	50.00	300	265	55	4.9	4.31	36	2.90	3.0442	0.0208	0.14	1.05	4.97
143	0.00	0.00	0.00	300	265	55	2	2.76	36.5	2.49	2.4914	0.0000	0.00	1.00	0.06
144	1.00	100.00	50.00	300	265	55	2	2.76	37.8	4.91	4.7743	0.0184	0.14	0.97	(2.76)
145	0.00	0.00	0.00	300	265	55	3.4	2.76	33.4	1.22	1.2449	0.0006	0.02	1.02	2.04
146	1.00	100.00	50.00	300	265	55	3.4	2.76	33.1	3.11	3.0745	0.0013	0.04	0.99	(1.14)
147	0.00	0.00	0.00	300	265	55	4.9	2.76	36.1	1.06	1.0398	0.0004	0.02	0.98	(1.90)
											Sum =	1.5603	8.7299	max err%=	30.4982
														min err%=	-23.9055

Max Square Error	0.1700	Max Abs Error	0.4123
Min Square Error	0.0000	Min Abs Error	0.0002
Arith. Mean	0.0106	Arith. Mean	0.0594
St.Dev.	0.0312	St.Dev.	0.0845