APFNet programme

Name:
Student number:
(Open book exam, submitted with your excel solver solutions)

Managing and assessing the dynamics of forest plantations for sustainable timber yield and carbon sequestration: a model-based approach

Q1. Use a forest growth and yield model from your countries/regions (or Appendix) to predict timber yield by timber categories (sawlog/pulpwood, or cords/bd ft.) from thinnings and rotation for each 10-year period up to a recommended rotation length (hint: you might have periods without thinning). (10 points)

Q2. Refer realistic pulpwood and sawlog (cords/bd ft.) prices, as well as carbon price (hint: from journal articles, statistical year book of forestry, FAO, IPCC or wood markets). (10 points)

Q3. Find the unit cost of stand establishment (hint: regeneration methods) and silvicultural treatments, as well as biomass equations from references. (10 points)

Q4. Compute the stream of harvest income and logging cost (hint: logging methods) over the rotation. (10 points)

Q5. Form a 120 ha forest with 6 forest stands of different age and unequal area. Each forest stand follows the growth model (in Q1) from its initial age onwards. When you decide the final harvest for any one of these stands, or a fraction of a stand, the rotation starts over for the harvested areas and follows the growth model. (10 points)

Q6. Construct the growth model for eight 10-year periods for total 80 yrs in Excel. (10 points)

Q7. Run Excel Solver to maximize the BLV (bare land value) of the forest at a 3% discount rate (hint: Faustmann model). What is your management plan for the forest (hint: harvest scheduling, periodic net returns, BLV, etc.)? (10 points)

Q8. Modify the problem to require a non-declining even flow of net revenues for the forest. Compare to your management plan in Q7 and report the loss in BLV due to the even-flow constraint. (10 points)

Q9. Add constraints that aim to a steady state forest. What is your management plan now? (10 points)

Q10. Link the growth model with biomass equations, add carbon price, and formulate it as a joint production problem (hint: Hartmann model). What is your management plan now? (10 points)

Appendix. Yield tables for pine and spruce plantations

Chinese pine,
SCI (site class index) = 13 m,
rotation = 80 yrs,
number of thinnings = 3,
thinning intensity = 10%

Age, yrs	Height, m	N, trees/ha	G, m2/ha	V, m3/ha
20	10.1	1500	17.2	97.0
25	11.7	1109	19.5	122.7
30	13.0	907	21.1	145.5
35	14.2	785	22.4	165.8
40	15.3	705	23.4	184.2
40	15.3	648	21.1	166.1
45	16.2	648	24.3	200.7
50	17.1	606	24.9	215.8
50	17.1	574	22.4	193.6
55	17.9	574	25.5	229.5
60	18.7	548	26.0	242.2
65	19.4	527	26.4	253.8
65	19.4	510	23.8	228.7
70	20.0	510	26.8	264.6
75	20.6	496	27.1	274.6
80	21.1	483	27.4	283.9

Timber grading equations:

V_sawlog = 0.0042*D^3-0.5405*D^2+23.521*D-285.41

D<15cm, V_pulpwood = 0.035*D^3-3.156*D^2+69.525*D-368.39

D>=15cm, V_pulpwood=18699*D^(-2.322)

Red pine,
H50 (dominant height at age 50 yrs) = 50 ft,
Rotation = 165 yrs,
Thinning intervals = 10 years,
Basal area after thinning = 90 f^2

Age, yr	Hdom, ft	G, f^2/acre	V, f^3/acre	V_removals, f^3/acre	cords_removals	bd. ft._removals
25	24.5	90.0	900			
35	35.5	90.0	1300	780	7.5	
45	45.5	90.0	1670	880	8.5	
55	53.5	90.0	1970	920	8.9	4700
65	60.0	90.0	2210	890	8.6	4600
75	66.0	90.0	2430	850	8.2	4300
85	71.0	90.0	2610	780	7.6	4000
95	75.0	90.0	2760	710	6.9	3600
105	78.5	90.0	2890	630	6.1	3200
115	81.0	90.0	2980	550	5.3	2800
125	83.0	90.0	3050	470	4.5	2400
135	84.5	90.0	3110	410	4.0	2100
145	85.5	90.0	3140	350	3.4	1800
155	86.5	90.0	3180	320	3.1	1600
165	87.0			3480	33.7	17800

Norway spruce,
H100 (dominant height at age 100 yrs) = 27 m,
rotation = 80 yrs,
number of thinnings = 2,
thinning intensity = 35%

Age, yrs	Height, m	N, trees/ha	G, m2/ha	V, m3/ha	Sawlog, m3/ha	Pulpwood, m3/ha
25	7.7	2000	8.4	31.0		22.9
30	10.0	2000	15.6	71.7		64.9
35	12.2	2000	22.6	123.9	2.2	115.4
40	14.1	2000	29.1	182.7	22.5	154.0
40	14.1	1006	18.2	118.8	22.5	93.2
45	15.9	1006	23.3	171.8	73.3	95.6
50	17.4	1006	27.8	224.5	118.4	103.1
55	18.9	1006	32.1	278.2	170.0	105.4
60	20.2	1006	36.0	332.2	225.2	104.2
60	20.2	561	22.9	215.9	160.9	53.5
65	21.4	561	26.1	266.3	215.2	49.6
70	22.4	561	29.1	309.5	262.1	46.1
75	23.4	561	31.8	352.3	308.1	42.9
80	24.3	561	34.5	394.3	352.6	40.3

Scots pine,
H100 = 24 m,
rotation = 80 yrs,
number of thinnings = 3,
thinning intensity = 35%

Age, yrs	Height, m	N, trees/ha	G, m2/ha	V, m3/ha	Sawlog, m3/ha	Pulpwood, m3/ha
20	5.6	1800	6.3	19.0		
25	7.7	1800	11.1	42.4		35.1
30	9.7	1800	15.6	73.6		67.5
35	11.4	1800	20.0	110.2	0.1	104.5
40	13.1	1800	24.2	150.9	18.3	127.0
40	13.1	922	15.4	98.1	18.3	76.9
45	14.6	922	18.9	130.6	45.4	82.3
50	15.9	922	21.8	264.0	75.6	85.6
50	15.9	501	13.9	106.6	57.9	47.2
55	17.1	501	16.6	133.9	87.1	45.3
60	18.2	501	18.8	160.2	116.6	42.1
65	19.2	501	20.9	187.3	147.5	38.3
65	19.2	284	13.4	121.7	101.1	19.9
70	20.1	284	15.5	145.0	127.1	17.1
75	21.0	284	17.1	165.6	149.6	15.2
80	21.7	284	18.6	186.6	172.1	13.8