100 points **Name:** _____

FINAL EXAM-2005
FO-3015 Forest Description and Analysis

1. Define the following terms: (5)

   a) Scaling length -

   b) Stand and Stock table -

   c) Basal Area -

   d) Scaling diameter

   e) Form Class -

2. Given the following information from a timber cruise (1/5 acre fixed-plot cruise):

Number of sample plots	= 160 (t = 1.96)
Tract Acres	= 160
Mean sawtimber volume per plot	= 900 bd. ft per plot
Standard deviation of mean volume per plot	= 667.95 bd. ft per plot
Current timber value	= $400 per MBF

   a) The best estimate of mean volume per ACRE is: _____ (6)

   b) The sampling error at the 95% confidence level is: _____ % (5)

3. Data analysis showed a 10 year DBH growth rate of 1.9 inches for the 12-inch DBH class and 1.7 inches for the 14-inch DBH class (using **2-inch** classes). If there are 60 trees in the 12-inch class and 40 trees in the 14-inch class, complete the stand table below:

DBH Class	10yr Growth	Current No. Trees	Future No. Trees (in 10 yrs.)
12	1.9	60	_____
14	1.7	40	_____
__		____	_____
__		_____	_____

(8)

5. Map scales: Assume you are using the same stand maps used in the cruising exercises where the scale was 1:24,000 which equates to 1 inch = xx.xx chains or 1 inch = x,xxx feet thus,

a. if you measure the distance along Highway 25 between Morgantown Road and the Antioch Loop Road as 260/30 inches, the distance is computed to be approximately _____miles. (5)

b. if your tract was rectangular and measured 30/60 by 90/60 inches, the acreage would be computed to be _____ acres. (5)

6. You measured tree dbh and total height on 20 sample trees and your colleague in the class did the following computations for you. Since you didn't specify whether you wanted to use common or natural logarithms, he did both. Now, you must decipher his work for the height equation you need for your project.

trees#	DBH	Height		$Log_{10}(H)$	$Ln_e(H)$	(1/D)	(1/D)^2	$(1/d)*Log_{10}H$	$(1/d)*ln_eH$
1	16.3	86		1.934498	4.454347	0.06135	0.003764	0.118680887	0.27327284
2	21.3	96		1.982271	4.564348	0.046948	0.002204	0.093064377	0.21428865
3	18.1	91		1.959041	4.51086	0.055249	0.003052	0.108234331	0.24921876
4	18.3	88		1.944483	4.477337	0.054645	0.002986	0.106255884	0.24466321
5	20.2	94		1.973128	4.543295	0.049505	0.002451	0.097679597	0.22491558
6	17.9	95		1.977724	4.553877	0.055866	0.003121	0.110487352	0.25440653
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20	18.3	98		1.991226	4.584967	0.054645	0.002986	0.108810168	0.25054467
			Sums	39.54597	91.05795	1.181592	0.071967	2.33556107	5.3778281
							b	-0.37004358	-0.8520568
							a	1.999160331	4.60323678

If you choose the common logarithm **(i.e. $\log_{10}$)** computations:

a) The equation for $\log_{10}H$ as a linear function $(DBH)^{-1}$ is:

_____(10)

b) The equation for H as a non-linear function of DBH is:

_____(10)

7. The 20 trees in Question 6 above were felled and the cubic volume was calculated using Smalian's cubic volume equation on 4 ft sections. The following computations were completed by your colleague, but he failed to give you the final volume equation.

Tree#	DBH	Hgt	CV3,ob		(DBH^2Hgt)	$(DBH^2Hgt)^2$	$(DBH^2Hgt)*CV3$
1	16.3	86	35.18		22849.34	522092338.4	803908.3292
2	21.3	96	31.48		43554.24	1896971822.0	1371087.475
3	18.1	91	47.43		29812.51	888785752.5	1414007.349
4	18.3	88	108.79		29470.32	868499760.9	3206076.113
5	20.2	94	43.22		38355.76	1471164325.2	1657735.947
6	17.9	95	50.06		30438.95	926529677.1	1523773.837
7	17.3	99	44.41		29629.71	877919714.7	1315855.421
8	18.1	95	65.41		31122.95	968638016.7	2035752.16
9	17.5	94	22.83		28787.5	828720156.3	657218.625
10	12.1	91	16.03		13323.31	177510589.4	213572.6593
11	12.7	80	76.94		12903.2	166492570.2	992772.208
12	21.0	88	34.81		38808	1506060864.0	1350906.48
13	20.5	101	83.87		42445.25	1801599247.6	3559883.118
14	17.9	101	59.35		32361.41	1047260857.2	1920649.684
15	14.0	107	32.99		20972	439824784.0	691866.28
16	14.6	103	65.94		21955.48	482043102.0	1447744.351
17	21.5	93	91.63		42989.25	1848075615.6	3939104.978
18	17.1	108	76.40		31580.28	997314084.9	2412733.392
19	13.4	95	46.53		17058.2	290982187.2	793718.046
20	18.3	98	33.20		32819.22	1077101201.4	1089598.104
SUMS			**1,066.50**		**591,236.90**	**19,083,586,667.20**	**32,397,964.60**
Corrected						**1,605,534,253.60**	**870,169.20**

The linear equation for Cubic Volume, o.b., to a 3inch top as a linear function of (DBH^2Hgt) is:

_____ (10)

8. Mesavage and Girard Form Class is a measure (expression) of: (2)
   a. the cord volume of a single tree.
   b. the average taper of the first 16 ft. log in relation to tree DBH.
   c. the board foot volume of a stand of trees.
   d. the suitability of a tree as a sawlog or for sawtimber.

9. You completed a strip cruise of a 30.0 acre tract using strips that were 1.0 chains in width (at 5 chain intervals) and 56 chains in cumulative length. You tallied sawtimber on the entire strip width and pulpwood on the <u>right half of each strip</u>. The tally volume was 45.6 cords of pulpwood and 22,420 board feet, Doyle, of sawtimber.
   The cruise intensity and average volume per acre for SAWTIMBER was: (2)
   a. 20 percent and 3,737 bd.ft. per acre
   b. 20 percent and 4,004 bd.ft. per acre
   c. 18.67 percent and 3,737 bd.ft. per acre
   d. 18.67 percent and 4,004 bd.ft. per acre

10. POINT SAMPLE: You performed a point sample cruise with a BAF 10 prism on 5 points.

Sample plot and stand table calculations from BAF10 point cruise on 40 acres.

Sample point Computations:

Plot	Tally DBH	Tally Trees	Per Acre Trees	Per Acre Volume	Plot Total
1	12	3	38.20	2750.28	
	10	3	55.01	3300.33	
	14	2	18.71	1571.59	
					7622.19
2	10	3	55.01	3300.33	
	12	2	25.47	1833.52	
	14	1	9.35	785.79	
					5919.64
3	14	1	9.35	785.79	
	12	3	38.20	2750.28	
	10	5	91.68	5500.55	
					9036.62
4	10	2	36.67	2200.22	
	14	1	9.35	785.79	
	12	3	38.20	2750.28	
					5736.29
5	10	3	55.01	3300.33	
	14	2	18.71	1571.59	
	12	2	25.47	1833.52	
					6705.43

Totals		36	**Sum of Plots**	524.37		35020.17	BF Doyle		**Std. Dev.**	1358.839

	Doyle BF Per Tree	
	DBH	**Volume**
	10	60
	12	72
	14	84
	16	96
	18	108

Sample stand table computations:

	Tally DBH	Tally Trees
	10	16
	12	13
	14	7
Totals		36

	.....	....Per Acre	.....
DBH	**Trees**	**Volume (Doyle)**	**Basal Area**
10	**58.67**		
12			
14			
Totals	**104.87**		

a) Complete the stand table computations above. (10)

b) Best estimate of volume per acre is _____ board ft Doyle per acre. (5)

c) If the allowable error for this cruise was +/- 15% of mean volume at the 95% confidence level, was the volume precision specification met?

Value = _____% (Yes/No) (5)

11. DOUBLE POINT SAMPLE: Suppose the point sample in Questions 10 above was the 5 volume points from a BAF 10 **double** sample with an 8:1 count to volume ratio.

Additional data from double sample cruise:

Count points	= 40
Volume points	= 5
Total Points	= 45

Tree Tally:	= 234 trees on 40 Count points
	= 36 trees on 5 Volume points
Total trees	= 270 trees on 45 Total BAF 10 points

From volume points regression of volume as a function of basal area:
Volume =a + b(BA)} where a =3,980 and b=42.0

a. Compute the large sample (i.e. overall) basal area per acre: (4)

b. Compute the adjusted Doyle volume per acre with the linear regression adjustment formula: (4)

12. A tree that measures 14.5 inches, DBH, with a bark thickness of 1.5 inches has a basal area of:

a. 0.922 sq.ft. (2)
b. 1.147 sq.ft.
c. 0.855 sq.ft.
d. 0.65 sq.ft.

13. The board foot volume, Doyle Log Scale, of a log that scales 14.9 inches (o.b.) at the small end with 0.3 inches of single-bark and measures 16 feet in length is:

a. 98.3 bd.ft.
b. 100.0 bd.ft.
c. 75.0 bd.ft.
d. 87.5 bd.ft. (2)

Bonus #1: 5 points (all or none)

The plot radius of a 0.05 acre plot is: _____ feet.

Bonus #2: 5 points (all or none)

For a BAF 7.5 prism:

An average tree diameter of _____ inches will equate to an average plot size of 0.1 acres.

USEFUL FORMULAE

Variable Definitions:

a = plot size in acres
A = total tract area in acres
N = A/a = total number of plots of size a on the tract
a' = 1/a = factor for expanding plot values to per acre values
x_i = volume on the ith measurement plot
n = number of sample plots of size a measured for volume
y_i = (a')x_i = volume per acre represented by the ith plot
$t_{d,p}$ = Student's t table value for "d=n-1" degrees of freedom and probability level p

Statistical Formulae:

Per Plot Average:

$$\bar{x} = \frac{\left(\sum_{i=1}^{n} x_i\right)}{n}$$

Per Plot Standard Deviation: (variance = s_p^2)

$$s_p = \sqrt{\frac{\left(\sum_{i=1}^{n} x_i^2 - n\bar{x}^2\right)}{n-1}} = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}} = \sqrt{\frac{S_{xx}}{(n-1)}}$$

Per Plot Standard Error of the Mean:

$$s_{\bar{x}} = \sqrt{\frac{s_p^2}{n}} = \frac{s_p}{\sqrt{n}} \quad or \qquad s_{\bar{x}} = \sqrt{\frac{s^2}{n}\left(1 - \frac{n}{N}\right)}$$

Coefficient of Variation: $CV = \frac{s_p}{\bar{x}}(100) = \frac{s_a}{\bar{y}}(100)$

Sampling Error: $SE\% = \left(\frac{t_{d,p} s_{\bar{x}}}{\bar{x}}\right)100$

Confidence Intervals:

Per Acre $\bar{y} - (t_{d,p})s_{\bar{y}} \le \text{true mean} \le \bar{y} + (t_{d,p})s_{\bar{y}}$

Sample Size Required to be Within Plus or Minus P_e Percent of the True Mean with Probability 1-p:

$$n = \frac{1}{\frac{1}{N} + \left(\frac{P_e}{(t_{d,p})\,CV} \right)^2}$$

If the maximum error is expressed in absolute terms (A_e), then the sample size estimation equation becomes,

$$n = \frac{1}{\frac{1}{N} + \left(\frac{A_e}{(t_{d,p})\,s_a} \right)^2}$$

Point and Double Point Sampling:

Plot Radius Factor(PRF) - the factor a tree's dbh is multiplied by to determine its plot radius

$$PRF = \frac{8.696}{\sqrt{BAF}}$$

Plot Radius(PR) - a tree must be within this radius to be an in-tree

$$PR = (PRF)(dbh)$$

Basal Area Factor(BAF) - basal area per acre represented by each in-tree

$$BAF = \frac{75.625}{PRF^2}$$

Basal Area Per Acre(BA) - basal area per acre represented by the in-trees at a point

$$BA = (\text{IN-TREE COUNT})(BAF)$$

Number Of Trees Factor(NTF) - number of trees per acre (also called PACF) represented by an in-tree on a point

$$NTF = \frac{BAF}{(\text{Tree basal area})} = \frac{BAF}{.0054541(dbh^2)} = \frac{183.3483BAF}{dbh^2}$$

Volume Basal Area Ratio(VBAR) - the ratio of tree volume to tree basal area

$$VBAR = \frac{(\text{Tree volume})}{(\text{Tree basal area})} = \frac{\text{Tree volume}}{.005451(dbh^2)} = \frac{183.3483(\text{Tree volume})}{dbh^2}$$

Volume Per acre(VPA) - volume per acre represented by an in-tree at a point

VPA = (NTF)(Tree volume) = (VBAR)(BAF)

Double point, volume estimate Regression adjustment formula

$$\overline{Y_{adj}} = \overline{y} + b(BA - ba)$$

where:

$$\boldsymbol{b} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sum X^2 - \frac{(\sum X)^2}{n}} = \frac{\sum xy}{\sum x^2} = \frac{S_{xy}}{S_{xx}}$$

b= slope of regression = change in volume per 1 square foot of basal area
BA = large sample basal area per acre (count plus volume points)
ba = small sample basal area per acre (volume points only)

Regression coefficients

model: $Y = a + bX$

$$\boldsymbol{b} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sum X^2 - \frac{(\sum X)^2}{n}} = \frac{\sum xy}{\sum x^2} = \frac{S_{xy}}{S_{xx}} = \frac{corrected\ sum\ of\ XY}{corrected\ sum\ of\ X^2}$$

$$a = \overline{y} - b\,\overline{X}$$

Log Rule

$$Doyle\ bd.\ ft = \frac{(D - 4)^2\ L}{16}$$

Student's t-Table

Forest Description and Analysis

The Distribution of Probability

df	0.5	0.4	0.3	0.2	0.1	0.05	0.02	0.01	0.001
1	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619
2	0.819	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598
3	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	12.941
4	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610
5	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	6.856
6	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	5.405
8	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11	0.697	0.876	1.088	1.363	1.769	2.201	2.718	3.106	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140
15	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965
18	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.850
21	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767
24	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690
28	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659
30	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646
40	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551
60	0.679	0.848	1.046	1.296	1.671	2.000	2.390	2.660	3.460
120	0.677	0.845	1.041	1.289	1.658	1.980	2.358	2.617	3.373
∞	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291

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							b	-0.37004358	-0.8520568
							a	1.999160331	4.60323678

If you choose the natural logarithm **(i.e. ln_e)** computations:

a) The equation for $ln_e H$ as a linear function $(DBH)^{-1}$ is:

_____(10)

b) The equation for H as a non-linear function of DBH is:

_____(10)