TSM 330, Spring 2007 **Test Exam 1** Name_____

Instructions:

Answer 3/? out of the 5/? questions. At least one question must be answered from two different sections:

(Note: In the actual test there will most likely be only 2 questions for each section. It is possible each question will be slightly shorter to save time. However, if you do not know you work, you will be time limited)

No extra credit will be given for more than three? answers. If more than three? questions are attempted, CLEARLY indicate which questions are to be graded, otherwise only the first three? answers will be graded, and the rest ignored.

Show all calculation steps to ensure that partial credit is earned, even if the final answer is incorrect. In cases where the answer is obviously wrong, some credit will be given if you identify this as an improbable answer.

If you make any assumptions, clearly state these assumptions. If you run out of time briefly describe how you would answer the remaining questions, to receive partial credit

Statistics

Mean = $1/N * \sum X_i$, Std Dev = $\{1/(N-1) * [\sum(X_i^2)-1/N*(\sum X_i)^2]\}^{0.5}$

Soils and Tillage

Porosity, $n = V_v / V_t$ Void Ratio, $e = V_v / V_s$ Water/Moisture Content MC = M_w / M_s

Draft Forces $\mathbf{D = F_i[A+B(S)+C(S)^2]WT}$

D, is implement draft, N (lbf); S, implement Speed. kmh (mph)

F, dimensionless texture adjustment parameter A, B and C are machine-specific parameters

i = 1 for fine, 2 for medium and 3 for coarse soils W is machine width, m (ft), (or # rows or tools)

T is tillage depth, cm (in.) for major tools, 1 for minor tillage tools and seeding implements.

Orifice Flow:

$\mathbf{Q = -.0342 + 770\ A_n * (g*D_e)^{(0.5)}}$ Where: D_e=D-k*d (circular), k=1.4

a'=a-k*d, b'=b-k*d, $D_e = 0.5*a'*b' /(a'+b')$ (rectangular)

1 mile = 5280 ft, 1 km = 1000m

1 acre = 43,560 square ft 1 ha = 10,000 square meters

1 gal = 231 cubic inches 1 litre = 1000 cubic cm (or 1000 mL)

Section 1: Soils, Tillage, Draft

Question 1: A soil sample is taken from a field prior to tillage. The dry bulk density of the soil is 1.71875 g/cc, and the degree of saturation is 80%. The particle density is 2.7 g/cc. Determine:

i). The porosity and void ratio of the sample.
ii). The mass of soil and water in 1 cc of bulk sample.
iii). The wet bulk density and water content of the soil.

After tillage the total void volume increases by 40%. After a period of time the moisture content of the tilled soil is 16%. A second soil sample is taken from a field. (The particle density does not change.) Determine:

iv). The total volume of bulk tilled soil occupied by 1.71875 g of dry soil.
v). The mass of water in the total volume of soil found in part (iv).
vi). The porosity and void ratio of the tilled soil sample.
vii). The degree of saturation of the tilled soil sample.
viii). The dry and wet bulk density of the tilled soil sample.

Question 2: A soil sample is taken from a field. The dry bulk density of the soil is 1.35 g/cc, and degree of saturation is 40%. The particle density is 2.7 g/cc. Determine:

i). The mass of soil, mass of water, volume of soil particles, void volume, and water volume in 1 cc of the bulk sample.
ii). The water content (moisture content) of the bulk sample.
iii). The porosity and void ratio of the sample.
iv). The wet bulk density of the soil

After compaction of the soil the void volume is decreased such that the degree of saturation is now 80% for the tilled soil without any loss of water from the soil. A second soil sample is taken from a field. (The particle density is still 2.7 g/cc) Determine:

v). The new void volume of the soil
vi). The porosity and void ratio of the compacted soil sample.
vii). The dry and wet bulk density of the compacted soil sample.
viii). The water content of compacted soil sample.

Question 3: Part i). Consider a 20-foot (6.1 m) wide tandem disk harrow operating 4 inches (10.2 cm) deep at 5.25 mph (8.46 km/hr) in medium soil. Determine the following:

a) Specific draft.
b) Drawbar power required.

Part ii) You are to advise a farmer about the size of a moldboard plow and a tandem disk harrow for a John Deere 4555 tractor. Nebraska Tractor Test 1629 shows the 2-wheel drive tractor developed 156.83 pto hp (116.95 kW) and the drawbar power is 75% of of the PTO power at a speed of 4.83 mi/hr (7.77 km/h) in fifth gear and 5.97 mi/hr (9.61 km/h) in seventh gear. The soil texture for both moldboard plowing and disking is medium. The disk is to be used for secondary tillage. The farmer's questions in regard to the plow are:

a) What size moldboard plow should I purchase for the tractor? Assume plow bottoms are available only in widths of 18 inches (45.72 cm).
b) In what gear do you recommend I pull the plow?
c) What size disk (width) should I purchase?
b) In what gear do you recommend I pull the disk?

Section 2: Planters

Question 4: A seeder is used to broadcast wheat at a travel velocity of 18 km/hr, with a 30 m swath width, through a rectangular orifice opening. The orifice is size is a 25 mm by 50 mm The following information of wheat is provided.

Bulk Density .68 kg/L, Seed Count 22,500 seeds/L,
Germination rate 90%, Mean Diameter 4.10 mm,

Determine:

i). Determine the theoretical flowrate through the orifice.
ii). Calculate the theoretical application rate at this velocity.
iii). Determine the actual population of wheat after germination.

Question 5: A seeder is used to drill alfalfa at a seeding rate of 10 kg/ha, at a travel velocity of 14.4 km/hr, with a 0.10m row width, through fluted wheel metering device, with 10 cells. The following information of alfalfa is provided.

Bulk Density .77 kg/L, Seed Count 339,000 seeds/L,
Germination rate 80%, Mean Diameter 1.53 mm,

Determine:

i). Flowrate through the fluted wheel required for this application rate.
ii). The required speed of rotation, if the individual cell volume is 113 mm^3
iii). Determine the seeding rate under these conditions if 50% of the cell volume of the fluted wheel is covered.

Question 6: A precision planter is used to plant corn in 0.762 cm rows (30"), traveling at 7.2 kmh (4.5 mph). The target population after germination is 74,000 plants/ha (30,000 plants/acre), and the germination rate is 80%. The rolling radius of the planter wheel is 0.30m (12") and has a slip of 5%. The seed plate has 12 cells per revolution.

Determine:

i). The actual planting population required
ii). The nominal seed spacing of the plants.
iii). The required rotational speed of the metering device.
iv). The ratio of the metering disk speed to the planter wheel speed.

Question 7: A precision planter is used to plant corn in 76.2 cm rows (30"), traveling at 7.2 km/h (4.5 mph). The rolling radius of the planter wheel is 0.50 m (20") and under the conditions in the field the wheel slip is 5%. The gear ration between the planter seed plate and the planter wheel is such that the seed plate is rotating at 1.5 times the speed of the wheel. The seed plate has 12 cells per revolution (i.e. 12 seeds per revolution).

Determine:

i). The actual rotation speed of the wheel accounting for wheel slip.
ii). The rotation speed of the planter plate.
iii). What is the planting population achieved in this field.
iv). If the germination rate after planting is 90%, what is the final population after germination.