TSM 330, Spring 2006 **Test Exam 2** Name_____

Instructions:

Answer 2/3 out of the 6 questions.

No extra credit will be given for more than two/3 answers. If more than two/.3 questions are attempted, CLEARLY indicate which questions are to be graded, otherwise only the first two 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.

Allowed I page cheat sheet and following equations:

Equations given:

Cost Analysis

$$I_r = \frac{I_p - I_g}{1 + I_g} \qquad Cos = (1 - Sv) * \frac{[I_r (1 + I_r)^{\tau_L}]}{[(1 + I_r)^{\tau_L} - 1]} + \frac{K_{tis}}{100}$$

Fuel Costs

X<0.856 SFCv = 3.91+2.64X - 0.203*(173+738*X)$^{0.5}$ L/kW.h,
X>0.856 SFCv = 0.411 L/kW.h
X<0.856 SFCv = 0.77+0.52X - 0.04*(173+738*X)$^{0.5}$ gal/Hp.h,
X>0.856 SFCv = 0.081 gal/Hp.h

Repair Costs

$C_{R\&M} = Pu*RF1*(t/1000)^{RF2}$

Timeliness Costs

$$C_t = \frac{K_r * A * Y * V}{\lambda_o * T * C_a * P_{wd}}$$

Optimum Capacity

$$C_{aopt} = \sqrt{\left[\frac{A}{C_{os} K_p}\right]\left[L_c + T_{fc} + \frac{K_r * A * Y * V}{\lambda_o * T * P_{wd}}\right]}$$

Ct = Timeliness Cost ($/ha, $/ac)
A = Area
V = Crop Value
Ca = Effective Field Capacity
λ = Timeliness factor (=2 or 4)
Kr = Timeliness Co-eff (Decimal loss per day)
Y = Crop Yield
T = Working hours per day
Pwd = Probability of working day.
Kp = Unit Price

++

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)

Note: The question below are giver to cover the different types of questions that may be asked in the test. The test questions will generally not be a long as some of these questions. However, I have provided these for practice and to emphasized the basic principles that you need to understand.

Question 1.1: The following data was collected from a field test for corn with a 12 row rotary self-propelled combine, (0.762m or 30 in rows). The gross yield on the field before any loss was 10 Mg/ha (160 bu/acre). The combine traveled at 7.2 km/h (4.5 mph). The measured losses over a 10 square meter area (108.9 square foot) were as follows:

Preharvest Loss 75 g (0.003 bu), Header Loss 25 g (0.001 bu),
Threshing Losses 200 g (0.008 bu) Cleaning Losses 250 kg (0.01 bu)

Determine the following information

(a) The percent Pre-Harvest Loss, prior to harvest.
(b) The percent Header Loss.
(c) The percent Threshing Loss.
(d) The percent Cleaning Loss
(e) The mass flowrate of corn measured by a grain yield monitor entering the grain bin.

Question 1.2: The following data was collected from a 300 ha (750 acre) field test for corn with a 12 row rotary self-propelled combine, (0.762m or 30 in rows). The yield monitor displays a yield of 12.5 Mg/ha (200 bu/acre). The combine traveled at 7.2 km/h (4.5 mph). The farmer is aware of the following losses before and during the harvest operations (For simplicity, you may assume that these losses are based on harvested yield):

Pre-harvest Loss 0.5%, Header Loss 0.25%
Threshing Losses 1% Cleaning Losses 3%

Determine the following information

(a) The total mass of grain per hectare (acre) on the ground prior to harvest.
(b) The total mass of grain per hectare (acre) on the ground after header passes over the ground
(c) The mass flowrate of unthreshed corn leaving the rear of the combine
(d) The mass flowrate of threshed corn leaving the rear of the combine
(e) The gross yield of the field prior to any losses.

Question 2.1. A combine with a 9000 kg (350 bu) grain tank and 9 m (30 ft) platform head, is capable of harvesting soybeans at 7.2 km/h (4.5 mph). The beans are yielding 2.5 Mg/ha (40 bushels/ac) and are in 800m (1/2 mile) rows, and have been planted by a bean drill. The operator allows on average a 0.3 m (1 ft) overlap of the head when operating (i.e. 0.3 m of the head is over previously cut area). The average turn time at the end of field rows for the combine is 30 seconds. The unloading pattern of the operator is such that is the combine bin is unloaded when there is insufficient bin space to harvest one full row out and back to the trucks. The average time for the combine to travel to trucks, position the combine and return to the start of the next row is 1 minute. The combine unloading auger has a capacity of 5000 kg/min (200 bu/min).

a) Determine the theoretical Field Capacity, in terms of ha/hr (ac/hr) and Mg/hr (bu/hr).

a) Determine the Field Efficiency for the combine accounting for all inefficiencies.

a) Determine the Effective Field Capacity in terms of ha/hr (ac/hr) and Mg/hr (bu/hr) for the combine accounting for all inefficiencies.

Question 2.2 A combine with a 7500 kg (300 bu) grain tank and a sixteen-row corn head, is capable of harvesting corn at 7.2 km/h (4.5 mph). The corn is yielding 12.5 Mg/ha (200 bushels/ac) and is in 400m (1/4 mile) rows, and in 0.762 m (30 inch) row spacing. The average travel distance to the trucks for offloading is 200m (1/8 mile). The average turn time at the end of field rows for the combine is 15 seconds. The combine travels at a speed of 8 km/h (5 mph) to the truck and on the return trip. The unloading rate of the combine wagon is 4500 kg/min (180 bu/min).

a) Determine the theoretical Field Capacity in terms of ha/hr (ac/hr) and Mg/hr (bu/hr) for the combine.

b) Determine the Field Efficiency for the combine accounting for all inefficiencies.

c) Determine the Effective Field Capacity in terms of ha/hr (ac/hr) and Mg/hr (bu/hr) for the combine accounting for all inefficiencies in the operations.

Question 2.3. A large commercial self-propelled sprayer with a 1200 gallon (4500 l) tank and 90 ft (27m) spray boom is capable of 10 mph (16 km/h) in the field, and operates 10 hours per day. The application rate is 20 gal/acre (200 l/ha). The sprayer is used in a ½ mile (800m) long field and each turn at the edge of the field takes 25 seconds. On average, nozzle inspection and clean out, take about three minutes for each hour in the field. The field is 2 miles (3.5 km) from the closest tank fill-up point. The average road speed of the sprayer is 25 mph (40 km/h). The tank fill-up point is capable of delivering 50 gal/min (200 l/min) to fill the sprayer.

a) Determine the theoretical Field Capacity in terms of ha/hr (ac/hr) and l/hr (gal/hr) for the sprayer.,

b) Determine the Field Efficiency

c)Determine the Effective Field Capacity in terms of ha/hr (ac/hr) for the sprayer.

d) If the sprayer must cover a total of 2500 acres (1000 ha) under these conditions, how many days will it take to complete the spraying working for 10 hours a day, and that the probability of a working day is 75% during this time.

Question 3.1.

A 400 kW (500 Hp) combine is purchased for $500,000. The combine is partly used to harvest 400 ha (1000 acres) of soybeans, and 800 ha (2000 ac) of corn per year. The theoretical field capacity in corn is 6.5 ha/hr (16.25 ac/hr) with a field efficiency of 0.60 and the theoretical field capacity in beans is 7.0 ha/hr (17.6 ac/hr) with a field efficiency of 0.70, with a ten hour working day for both crops. The life of the machine is 2000 hours, and is sold the winter after this threshold is reached. The interest rate is 8% per annum and inflation is 1% per annum. Assume the annual charge for housing, taxes, and insurance is 2% of the purchase price. The labor costs are $10/hr and diesel fuel cost $0.50/l ($2.00/gallon). The engine operates at 60% of rated power and you may assume that the cost of oil and lubrication costs may be ignored. Assume that for repairs and maintenance RF1 = 0.007 and RF2 is 2.0. Assume that the salvage value of the machine is 10% of the purchase price.

i) Estimate the total average ownership costs per annum for the combine

ii) Estimate the ownership costs per ha for combining the soybeans and corn

iii) Estimate the combine operating costs per hour for the combine.

iv) Estimate the operating costs per ha for both corn and soybeans (Cost per ha for corn and cost per ha for beans)

Question 3.2: A combine (300 kW engine) with a 16 row header is capable of operating at 8 km/h in corn yielding 10 tonnes/hectare. Assume the engine runs at 75% of rated power. For labor, repair and fuel costs assume that the field efficiency of the combine is 0.65. The combine operates for a total of 500 hours per season, and the farmers buys a new combine every six years. The cost of the new combine is $500,000 and the salvage value after 6 years is $75,000. The interest rate is 10% and inflation rate is 1%. The total taxes, insurance and shelter costs are 2.5 % of the initial purchase price. The cost of labor and benefits is $15.00/hr. Diesel fuels cost are 75 cents per litre.

(i). Determine the fixed costs of ownership per annum.

(ii). Determine the specific fuel consumption, fuel consumption and fuel costs per annum.

(iii). Determine the labor costs per annum.

(iii). Determine the estimated average Repair and Maintenance Costs per year assuming RF1=0.04 and RF2=2.1

(iv). Determine the average combine harvest costs per hectare, and per tonne.

Question 4.1: A combine (225 kW engine, 300 Hp) with a 12 row header is capable of operating at 8 km/h (5 mph) in corn yielding 12.5 tonnes/hectare (200 bu/ac). The field efficiency of the combine is 0.65. The farmer harvests 1000 hectares of corn per season, and the farmers buys a new combine every five years. The cost of the new combine is $300,000 and the salvage value after five years is $75,000. The interest rate is 8% and inflation rate is 1%. The total taxes, insurance and shelter costs are 2.0 % of the initial purchase price. The cost of labor and benefits is $15.00/hr. Diesel fuels cost are 50 cents per litre ($2/gal) and you may assume that the engine operates at rated power. Assume that the timeliness coefficient is 0.002 and that the timeliness factor λ is equal to 4. The price of corn is $100/Mg ($2.50/bu). The probability of a working day is 0.65 during harvest.

(i). Determine the fixed costs of ownership per annum.
(ii). Determine the fuel costs per annum.
(iii). Determine the labor costs per annum.
iv) Determine the timeliness costs (per ha, per ac)
(v). Determine the average Repair and Maintenance Costs for assuming RF1=0.04 and RF2=2.1
(iv). Determine the average combine harvest costs per hectare, and per tonne.

Question 4.3.

Assume a farmer starts has to plant 1000 acres (400 ha) of soybeans. The farmer operates a 24 row planter planting on 15 inches (0.381 m) rows at 4.5 mph (7.2 km/h), working 10 hours a day and a field efficiency of 0.70. Maximum bean yield in the location occurs when planted from May 1 to May 15. The farmers starts planting on May 1. The timeliness coefficient after May 15 is .006. The probability of a working day during this period (May 1 to end of planting) in Iowa, is approximately 0.50 at a 90% probability level.

i) Determine the theoretical Field Capacity, and Effective Field Capacity in terms of ha/hr (ac/hr).
ii). Determine the total area of the field planted before any timeliness costs are incurred.
iii) Determine the total timeliness costs associated with this planting operation.
iv) If the price of beans is $6.00 per bu ($220 per Mg) what is the average timeliness cost in $/ac ($/ha) for the whole area.

Question 4.4: A combine with a 8 row (0.762 cm, 30") header is capable of operating at 8 km/h (5 mph) in corn yielding 10tonnes/hectare (160 bu/ac). The field efficiency of the combine is 0.65. The farmer harvests 1000 hectares of corn per season. Assume that the timeliness coefficient is 0.005 and that harvest operations are evenly balanced about the optimum harvest date. The price of corn is $100/Mg ($2.50/bu). The probability of a working day is 0.65 during harvest.

i) Determine the timeliness costs (per ha, per ac)
ii) Determine the total timeliness cost per year ($/annum)

Question 5.1.

A self-propelled combine rates at a maximum rate power of 225 kW (300 Hp) with a 9 m (30 foot) grain platform, is capable of harvesting beans at 7.2 km/h (4.5 mph). The beans are yielding 3.5 Mg/ha (50 bushels/ac). The field efficiency of the combine is 65%.

The combine purchase price is $300,000 and has an expected life of 10 years. The interest rate is 5% and inflation is at 2%. The salvage value of the machine after 10 years is 10% of the purchase price. Cost of taxes, insurance and housing is 2% of the purchase price per annum. The labor costs are $10/hr and diesel fuel cost $0.50/l ($2.00/gallon). On average the engine operates at 70% of rated power. Assume that for repairs and maintenance RF1 = 0.08 and RF2 is 2.1. The combine harvests 800 ha (2000 acres) per year, with 10 hours harvest days. Assume that the timeliness coefficient is 0.002 and that harvest operations are evenly balanced about the optimum harvest date. The price of beans is $220/Mg ($6.00/bu). The probability of a working day is 0.70 during harvest. The unit price function for combines is $25,000 h/ha

a) Determine the theoretical and actual field capacity of the combine (ha/hr, ac/hr).
b) Determine the annual ownership costs per annum (per ha, per ac)
c) Determine the operating costs excluding timeliness costs (per ha, per ac)
d) Determine the timeliness costs (per ha, per ac)
e) Determine the optimum effective field capacity.

Question 6.1 What combine adjustments, if any, are indicated by the following conditions and observations? (Note: You may submit answer on this paper.) Give reasons for your answer, my first thoughts may be different from yours but you may be able to convince me!!

a) The tailings elevator is carrying a large quantity of material consisting of 80% clean wheat, 15% unthreshed heads, and 5% chaff.
b) In soybeans, the beans in the grain tank are clean but about 50% of them split.
c) In corn, a large quantity of fine material, chaff and broken corn are found in the grain tank.
d) While working in soybeans a quick field check finds 2 percent of yield to be beans still in pods that went through combine.
e) A large amount of shelled corn is found on the ground near each row.
f) A large number of soybeans are found on the ground behind the combine in a swath about 8-feet wide (header is 22-feet wide).
g) You are harvesting a very low yielding field of corn and speed is limited by the terrain. You notice a large percentage of threshed corn kernels leaving the rear of the combine. What is the first combine adjustement you would make.

Classify the following statements as true (T) or false (F).

_____ H. The greater the overlap in a tillage operation, the lower the field efficiency.
_____ I. Usually the greater the travel speed, the lower the field efficiency.
_____ J. Field efficiency varies with all of the following: 1) percentage of effective width actually utilized, speed of travel while operating and while turning, and time to turn.
_____ K. Field efficiency is depends on the time to fuel the machine with fuel and travel time to the field.
_____ L. As threshing rotor speed goes up unthreshed crop proportion is decreased
_____ M. As threshing rotor speed goes up grain damage is decreased
_____ N. For sickle bar, increasing cutting frequency will increase the forward deflection of stalks
_____ O. Because rotary combine threshes grain mainly through a rubbing action, it is less prone to create grain damage than convention combine

Question 6.2 What combine adjustments, if any, are indicated by the following conditions and observations? (Note: You may submit answer on this paper.) Give reasons for your answer, my first thoughts may be different from yours but you may be able to convince me!!

a) The operating conditions are such that you are unable to fully load the combine. How would you change the combine rotor speed and fan speed settings. Give reasons for your answer.
b) You are observing a significant amount of damage to the crop in the grain bin. How would you change combine settings. Give reasons for your answer.
c) The tailing returns show a very high flowrate of chaff and fines and almost no grain is leaving the rear of the combine. How would you change the sieve settings. Give reasons for your answer.
d) The tailing return show a very high percentage of clean grain and almost no grain is leaving the rear of the combine. How would you change the chaffer sieve settings. Give reasons for your answer.
f) A significant amount of clean threshed grain is observed leaving the rear of the combine and the grain entering the grain bin is very clean with no damaged kernels or fine chaff material. Describe 2 settings you may change. Give reasons for your answers.
g) You are harvesting soybeans and notice a great variability in cut height, and the stalks are tending to be pulled forward. The floating platform appears to be set at the correct height and the height control is working correctly. Describe at least two things that you think may be causing this. (These could be machine settings or how the machine is operated) Give reasons for your answer.

Classify the following statements as true (T) or false (F).

_____ H. The greater the overlap in a tillage operation, the lower the field efficiency.
_____ I. The larger the machinery the higher the field efficiency.
_____ J. The field efficiency will be affected by both the field size and machinery size
_____ K. A large high speed sprayer would have a greater field efficiency than a small low speed sprayer.
_____ L. As combine fan speed is increased the threshing losses decrease.

_____ M. Increase in grain in the tailings return auger will increase grain damage.

_____ N. Because rotary combine threshes grain mainly through a rubbing action, it is less prone to create grain damage than convention combine

.