AE 340, Fall 2006 **Test Exam 3** Name_____

Instructions:

Answer 3 out of the 6 questions.

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. I strongly suggest that you use metric units due to the many equations are given in metric units. Single page cheat sheet is allowed.

Question 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. 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 1/2 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 road speed of the sprayer is 30 mph (50 km/h) when empty and 25 mph (40 km/h) when full. 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, Effective Field Capacity and Field Efficiency in terms of ha/hr (ac/hr) and l/hr (gal/hr) for the sprayer.

b) 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. 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: A combine with a 16 row header (0.762m row width) is capable of operating at 7.2 km/h (4.5 mph) in corn yielding 12.5 tonnes/hectare (200 bu/ac). The corn rows are 800 m (½ mile) long and it takes 30 seconds to turn at the end of each row. The combine bin capacity is 9000 kg (350 bu), and the unloading auger capacity is 85 kg/s (3.3 bu/sec).

i). Determine the maximum theoretical field capacity of the combine (ha/hr, ac/hr).

ii). Determine the field efficiency of the combine assuming that sufficient grain cart capacity exists to unload on the go.

iii). Determine the effective field capacity of the combine (ha/hr, ac/hr), assuming that sufficient grain cart capacity exists to unload on the go.

iv). Determine the effective field capacity of the combine (ha/hr, ac/hr), assuming that sufficient grain cart capacity exists but only three 25 tonne trucks are available for transport from the field. The average speed of the trucks is 60 km/h (36 mph) and the elevator is 24 km (15 miles) from the field. The average delay unloading time at the elevator is 30 minutes.

(v). Determine the field efficiency of the combine for part (iv).

Question 5. 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 total ownership costs per ha for planting 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 6. 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%.

a) Determine the theoretical and actual field capacity of the combine (ha/hr, ac/hr).

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.

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)

If the unit price function for combines is $25,000 h/ha

e) Determine the optimum effective field capacity.

Question 7: 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 1500 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). Assume that the timeliness coefficient is 0.002 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 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 estimated Repair and Maintenance Costs for <u>each year</u> assuming RF1=0.04 and RF2=2.1

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