Examination:	Reverse Logistics Management (1624)
Semester:	Summer Semester 2008
Examiner:	Prof. Dr. Karl Inderfurth
Date:	02 August 2008
Permitted Aids:	English dictionary (English into to any other language) without any handwritten entries !
Instructions:	Complete exactly two (2) of the following three (3) questions. If all three are completed, only the first two will be evaluated. All questions will be weighted equally and are designed to be completed within 30 minutes. Good Luck!!

Question 1:

As Production controller for a firm which satisfies demand using both production and remanufacturing (which is treated as "good as new"), you must decide on the lot sizes for both production and remanufacturing. The firm receives an amount of returns (which is constant and deterministic) from the market and cannot be disposed of (i.e. they must be remanufactured). Until remanufacturing, returns are held in the recoverables inventory and charged a holding cost rate per unit per unit time. Produced or remanufactured items are held in the servicables inventory (and charged a holding cost rate also per unit per unit time) for customer demand, and it is assumed that all the units of a certain lot arrive at the servicables inventory at the same time (i.e. infinite production rate). Setting up to produce or remanufacture results given fixed costs. Demand is assumed to be constant and deterministic. For reasons of convenience, it was decided that the production follow a "one for one" policy, where one production lot is followed by one remanufacturing lot, and vice versa. Lastly, we assume that there are no lead times, no stockouts are permitted, and that all parameters remain constant over an infinite planning horizon.

a) Using the following notation, derive the optimal values for the decision variables by putting forth the total relevant cost function objective function and using the first derivative:

R	:	Returns (units per unit time)
D	:	Demands (units per unit time)
T	:	Cycle length (time units)
A_p	:	Setup costs for production ($)
A_r	:	Setup costs for remanufacturing ($)
h_r	:	Holding costs for recoverables ($ per unit per unit time)
h_s	:	Holding costs for servicables ($ per unit per unit time)
Q_p	:	Lot size for production (Decision variable)
Q_r	:	Lot size for remanufacturing (Decision variable)

b) Discuss the advantages and disadvantages of the "one for one" policy.

(Please turn over!)

Question 2:

A smelter obtains amounts of each item (measured in mass units) and refines it, receiving revenue per mass unit of each metal. In order to process each metal, we need at least a concentration (percentage of mass) B mass units of it, and must pay the setup cost F. Each mass unit of items processed results in item-independent variable costs. The objective function is profit maximizing and contains the revenue generated from the metal recovery, cost for setting up to recover metals, and the per unit variable cost. Constraint (1) connects X and G decision variables, (2) ensures setups are paid for, (3) ensures maximum available amount of items at each recycler is not exceeded, (4) ensures minimum mass concentration is met, if metal is recovered, (5) ensures that our capacity is not violated, and (6) that decision variables take on meaningful values.

$i = 1,...,I$ Item type index

$j = 1,...,J$ Recycler index

$k = 1,...,K$ Metal type index

$A_{i,k}$ Amount of metal k found per mass unit of item i (Mass)

B_k Minimum concentration of metal k needed if refined (% of Mass)

C Our capacity (in Mass)

F_k Setup cost to recover metal k

$G_{j,k}$ Amount of metal k processed from recycler j (Mass) (decision variable!)

M A very large number

R_k Revenue generated per (mass) unit of metal k

T_k Efficiency at processing metal k (percentage)

V Processing cost per (mass) unit

$W_{i,j}$ Weight of item i available for processing at recycler j(Mass)

$X_{i,j}$ Amount (in mass) of item i processed from recycler j (decision variable!)

$Y_{j,k}$ Binary: Setup for metal k arriving from recycler j (decision variable!)

a) Using the above given notation, put forth the objective function and constraints of the model.

b) For a problem with three (3) item types, two (2) recyclers, and two (2) metal types, write out each of the constraint (4) from the model above.

Question 3:

A firm collecting products at the end of their use by customers must decide on what to do with the product returns. There are several options available, among them being recycling and remanufacturing. Define and describe each of the product recovery management options, giving an example as well as an advantage and disadvantage of each and describing under which conditions certain options would be preferred.