※ 考生請注意：本試題 ☑可 □不可 使用計算機

一. [14%] A manufacturing plant must develop a cost estimate for a customer's order for four large turbine shafts. It is estimated that the first shaft will take 100 hours of shop time, and an 80% learning curve is expected.

(1) [4%] How many labor-hours should the fourth shaft require?

(2) [3%] How many labor-hours should the whole order for four shafts require?

(3) [3%] If the labor rate is $12.50 per hour and the pricing policy for the company is to double the labor cost of the order, what is the customer price for each shaft?

(4) [4%] Trouble is encountered on the order, and it is obvious that the original estimate was too low because it took 90 labor-hours for the third shaft. The company wants to approach the customer with a revised price for the order. What should the new price be for the whole order?

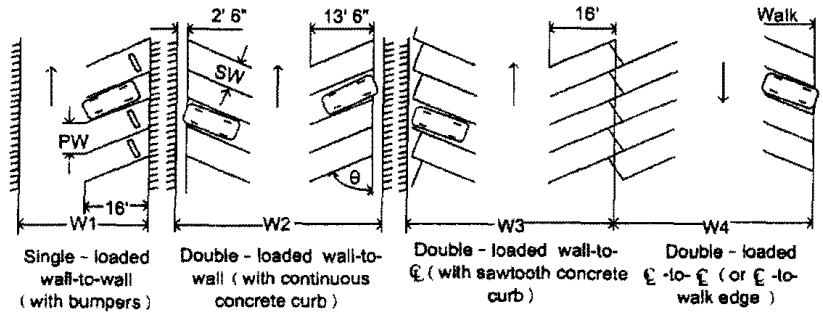
(Hint: $T_n = T_1(n^b)$ and b=log r/log 2 where T_1 is the labor-hours to produce the first unit, b is the slope of learning curve, and r is the learning rate percentage.)

二. [36%] 選擇題 (單選，每題 3%)

(1) 關於自動倉儲系統（AS/RS）設計，如果單負載的自動倉儲系統執行雙指令的週期時間為 3 分鐘，每小時完成 20 次雙指令存取週期，若有理想平衡的儲存和取貨的處理動作時，則產出率將是每個小時幾次存或取貨處理？ A.10 B. 20 C. 30 D. 40

(2) 關於自動倉儲系統（AS/RS）設計，一個雙指令的存取週期中，包含一個儲貨的動作與一個取貨的動作。假設雙指令的平均存取週期時間為 3 分鐘，且此自動倉儲系統 100%使用雙指令週期類型，則平均處理時間為幾分鐘？ A. 1.0 B. 1.5 C. 2.0 D. 3.0

(3) 下圖為停車場設計時的不同形式通道，下列陳述何者正確？
A. W2 大於 W1 B. W3 大於 W2 C. W4 大於 W3
D. 以上皆非



(4) 關於停車場設計，當 SW（Stall width）為 9 呎，停車角（Parking angle）為 90 度時，PW（Parking width）約為多少？
A. 7 呎 B. 8 呎 C. 9 呎 D. 以上皆非

(背面仍有題目,請繼續作答)

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(5) 通道平均每分鐘通過 105 人，人員的平均行進速度為每小時 3.2 公里，則通道所需之寬度為多少公尺？(Hint: 兩人前後最短距離為 1.5 m；人身寬約 0.76 m)
A. 1.0 B. 1.5 C. 2.0 D. 2.5

(6) 依據 TOC (Theory of Constraints) 的觀念，下列陳述何者正確？
A. 在「有效產出的世界」，集中焦點和持續改善是兩個不同的程序
B. 忙碌的工廠代表效率
C. 自動化設備一定能提高生產力
D. 以上皆非

(7) TOC 理論的設備啟動（Activation）定義為何？
A. What we can do? B. What we should do? C. How much to do?

(8) 對於拉式生產系統，下列陳述何者正確？
A. 下料時間是依外部排程而定
B. 下料時間是依內部狀態變化而定
C. 在製品由上游工作站作業員搬到下游工作站
D. 由下游工作站作業員到上游工作站取在製品

(9) 某工廠每年需求量為 10,000，每次訂購為 400 個，庫存成本每年每件為 0.4 元，每次定購費用 5.5 元，使用率每天 40 個，每天製造量 120 個，以 EPQ 模式來作訂購，Q*為何？
A. 563 B. 583 C. 623 D. 643

(10) 下列批量決策，何者可以減少 MRP 的系統敏感？
A. 在 BOM 上層用固定訂單數量
B. 在 BOM 中層用批對批
C. 在 BOM 下層用固定訂單期間
D. 以上皆是

(11) 回顧 ABC 存貨管理模式，下列何者為 C 類物料的管理原則？
A. 可採較嚴密的控制以減少管理成本
B. 採定期盤點方式，盡量簡化管理手續
C. 需維持較高之安全存貨
D. 以上皆是

(12) 根據 Little's Law 假設你要增加投料率 10%而且不增加你的產能，你想你的週期時間會有什麼改變？
A. ＜10% B. ＝10% C. ＞10% D. 無法確定

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三、[14%] A PC manufacturing company produces, assembles and ships a computer to its customer. Suppose there are totally 11 tasks $(A, B, ..., K)$ to be done for each deal, and the following table defines the preceding tasks (i.e. those tasks needed to be done before task i) and time required for each task i ($i \in \{A, B, ..., K\}$). Answer the following questions:

Task	Preceding Tasks	Processing time (Day)
A	None	3
B	None	2
C	A,B	2
D	C	4
E	C	3
F	D,E	2
G	C	3
H	G	1
I	F	5
J	H,I	2
K	J	10

(1) [4%] Draw the PERT diagram for each deal.

(2) [6%] What is the critical path for this deal? What is the minimum number of days to finish a deal?

(3) [4%] Calculating the critical path is in fact equal to calculating the longest path in the PERT diagram. It is known that seeking a longest path in a general graph is NP-hard. Is it possible to find a longest path in a PERT diagram in polynomial time (i.e. the upper bound in time for calculating a critical path is proportional to a polynomial function of nodes or arcs in the PERT diagram)? Explain your answer.

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四. [36%] A manager of a bicycle company considers to maintain one dedicated facility or one flexible facility in U.S. and Mexico, respectively. A dedicated facility can only sell products to its local market, while a flexible facility can sell products to both local and another markets. For example, if the manager decides to build a dedicated facility in U.S., while a flexible facility in Mexico, then the customers in U.S. can buy bicycles manufactured in either U.S. or Mexico, while the customers in Mexico can only buy bicycles manufactured in Mexico.
Let K_i^k and fc_i^k respectively represent the capacity (i.e. the maximum number of bicycles manufactured) and the annual fixed cost for a facility of type $k \in \{d, f\}$ in country $i \in \{U, M\}$, where d and f respectively represents for dedicated and flexible facility type, and U and M respectively represents for United States and Mexico.
Similarly, let vc_i^k represent the variable cost for manufacturing a bicycle in a facility of type $k \in \{d, f\}$ in country $i \in \{U, M\}$.
Let tc_{ij} represent the transportation cost for shipping a bicycle from country i to country j, where $i, j \in \{U, M\}$ (note that there are two possible cases: $i = j$ or $i \neq j$). Let r_i represents the unit revenue earned for selling one bicycle in country i. Suppose D_i represents the forecasted demands needed to satisfy in country i.
Let y_i^k denote whether to run a facility of type k (i.e. $y_i^k = 1$) in country i or not (i.e. $y_i^k = 0$).
Let x_i^k denote the amount of bicycles manufactured in the facility of type k in country i,
z_{ij} represents the amount of bicycles sold in country j which are transported from country i (note that there are two possible cases: $i = j$ or $i \neq j$)

Now the manager asks you to seek the **most profitable way** to maintain one facility in each country, to manufacture and ship bicycles to markets. Answer the following questions:
(1) [4%] Can this integer programming problem be solved by several linear programming problems? If yes, how to do ti? If no, why not? Explain your answer.

(2) [6%] List all the decision variables for this facility location problem. How many decision variables are there for this problem?

(3) [4%] Write the objective function. (**hint**: profit = revenue - cost)

(4) [4%] Write the capacity constraints associated with each facility of type k in country i. (**hint**: amount of bicycles manufactured in a facility cannot exceed its designed capacity)

(5) [4%] Write the constraints that describe only one type (i.e. either dedicated or flexible) of facility can be maintained in each country i.

(6) [4%] Write the flow balance constraints that describe the relationship between x_i^k and z_{ij}. (**hint**: amount of bicycles manufactured in country i equal to the amount of bicycled transported from it)

(7) [4%] Write the constraints that restrict the amount of bicycles transported to a country j to satisfy (i.e. no less than) its forecasted demand.

(8) [6%] Write the constraints that describe the relation between z_{ij} and y_i^d for each $i \neq j$. (**hint**: if a facility of type d is maintained in country i, then $z_{ij} = 0$ for $j \neq i$, and $z_{ii} \leq K_i^d$; otherwise, $\sum_{j \in \{U,M\}} z_{ij} \leq K_i^f$ in country i)