Study Guide for the Final Exam

ISE 453: Design of PLS Systems Fall 2018

Final Exam: Tue, 13 Dec, 8–11 a.m. in DAN 216. It is closed computer. You can bring one 8½ × 11 in. double-sided page of notes and your calculator. Study Chapter 6 of the Lecture Notes, ICA 16–18, and the parts of the Final Project that can be solved without the use of a computer, and the following problems:

1. With respect to the final project, what assumptions made it possible to design the facility so that it only satisfied the minimum throughput requirements?

2. With respect to the final project, why was it not necessary to use a procedure like SDPI to solve the machine layout problem?

3. With respect to the final project, what is an advantage and disadvantage of using a U-shaped layout as opposed to using a straight-line layout?

4. With respect to the final project, what is an advantage of having both low- and high-bay areas within the facility?

5. List the type(s) of pallet racks that will never result in honeycomb loss.

6. Explain why drive-in and drive-through storage racks might have greater potential for honeycomb loss as compared to other types of racks.

7. Why is a deep-reach pallet rack not appropriate when a FIFO retrieval policy is required?

8. What type of rack would likely be the most appropriate for the storage of 20-foot-long bar stock?

9. What storage alternative is both the storage medium and the transport mechanism?

10. How can a product be stored so that FIFO retrieval is possible even though not every load is always accessible?

11. What type of rack would likely be the most appropriate for the temporary outdoor storage of pallet loads of eggs?

12. What type of storage medium would likely be the most appropriate if each item in storage needs to be accessible at all times and space for storage is very expensive due to high land costs?

13. What type of storage medium would likely be the most appropriate to store a very large number of identical pallet loads of a single type of fragile and perishable item?

14. Explain the difference between zone and batch picking.

15. Why is lines-per-item usually a better measure of piece picking activity than the number of units picked?

16. Why is the cube of each item listed in the item master file, instead of just calculating its value using the product of the item's dimensions that are listed in the file?

17. Explain why multi-level pick to pallet is likely to be more appropriate for picking a large number of slow moving items as compared to floor-level pick to pallet.

18. List three different means of communicating piece-pick information to a picker.

19. Explain the difference between picking and putting.

20. Determine the cube per order and cube movement for the following item master and order dataset: (*Answer:* Cube per order = 2540 and cube movement = 1260, 384, 5400, and 576 for A–D)

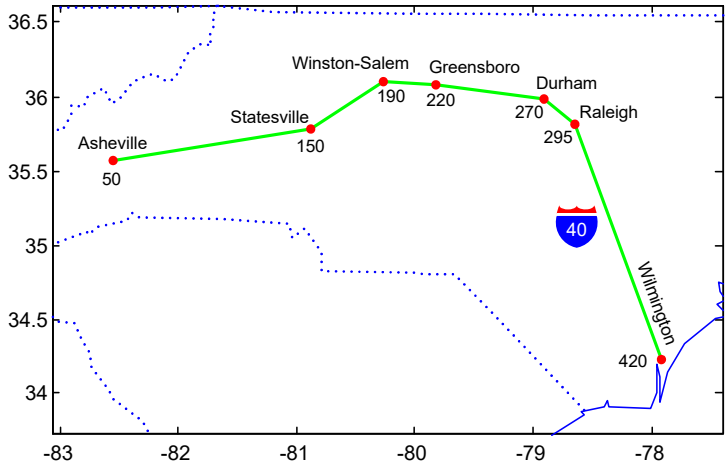
SKU	Length	Width	Depth	Cube	Weight
A	5	3	4	60	7.45
B	6	4	5	48	8.05
C	8	6	5	180	12.50
D	4	4	3	32	9.75

Order	SKU	Qty	UOM	Order	SKU	Qty	UOM
1	A	3	EA	2	C	12	EA
1	B	4	EA	2	D	6	EA
1	C	6	EA	3	A	6	EA
2	A	12	EA	3	C	12	EA
2	B	4	EA	3	D	12	EA

21. Determine the demand correlation distribution for the four SKUs in the following order dataset: (*Answer:* A-B,C,D = 0.2,0.5,0.1, B-C,D = 0.3,0.2, C-D = 0.2)

Order	SKU	Order	SKU	Order	SKU	Order	SKU
1	A	2	C	5	A	7	D
1	B	2	D	5	C	8	A
1	C	3	A	6	D	9	A
2	A	3	C	7	B	9	C
2	B	4	D	7	C	10	D

22. With respect to the final project analysis (but using different data): a facility will be built to produce 15,000 shields (product A) per year and distribute two associated products (B and C) to four customers located in Asheville, Durham, Greensboro, and Raleigh (see figure), each receiving 15, 24, 36, and 25%, respectively, of the total demand. Workstations with a line yield of 0.76 will be used to produce each shield. The associated products demand is proportional to the shield demand, with ratios of 0.85 and 1.25, respectively. The supplier of raw material is located in Statesville and the associated products are each purchased from suppliers in Wilmington and Winston-Salem, respectively. The raw material and associated products B and C are shipped P2P TL in 36 × 36 × 24 in. cartons, each weighing 240, 135, and 450 lb, respectively, and able to be stacked up to five high; each carton of raw material contains material for one unit of final product. Each carton of finished product weighs 210 lb, occupies 24 ft^3, can be stacked up to four high. Make reasonable assumptions for any data not provided.



(a) Assuming that full truckloads of a single product are shipped to the facility and full truckloads of a mix of all three products are distributed from the facility, where should the facility be located to minimize transportation costs? (*Answer:* Greensboro)

(b) Assuming that the revenue per loaded mile is $2.00, what is the total outbound transport cost from your facility to customers? (*Answer:* $37,923/yr)

(c) If it takes 30 minutes on average to load or unload each trailer and the facility operates for five eight-hour shifts per week, 50 weeks per year, what is the minimum number of shipping and receiving docks needed for the facility? (*Answer:* One dock, assuming a constant demand rate throughout the year)

23. With respect to the final project analysis (but using some different data): full truckloads of 48 × 42 × 30 in. four-way containers of raw material will be shipped P2P TL FOB origin from your supplier in Tampa, FL (27:57 N, 82:29 W) to your engine block sandcasting facility located in Richmond, VA (37:32 N, 77:28 W). The blocks are distributed to three customers located in Warren, MI (42:29 N, 83:01 W), Raleigh, NC (35:49 N, 78:39 W), and Houston, TX (29:46 N, 95:23 W), each receiving 35, 25, and 40%, respectively, of the total demand. The revenue per loaded truck-mile is $2.43. Each container load of raw material costs $350, weighs 425 lb, can be stacked six high, and contains material for one unit. Your facility will operate for 250 eight-hour shifts per year and is expected to produce 18,000 blocks per year. Workstations with a line yield of 0.78 will be used to produce each unit. The total investment cost for all of the equipment in your facility is $41 million, with a salvage value of 25%; the total investment cost for the site and building is $27.5 million. Your facility will have 45 direct laborers per shift, each at $15 per hour and indirect labor per shift (for the manager, administrative staff, etc., that are work each shift) at $275,000 per year. Assuming that the real cost of capital is 5% with annual compounding, the economic life the equipment and facility is 15 years, a circuity factor of 1.2, and that (unlike your final project) no associated products are distributed from your facility, what is the average production cost for each block at your facility? For any data not provided, you should use you the same values used in the final project. (*Answer:* $838.46)

24. A new warehouse is being designed to store 5,000 different SKUs. At its peak during the year, the warehouse will hold 120,000 loads. Randomized block stacking will be used to store 40 × 48 × 36 in. ($y \times x \times z$) two-way pallet loads and all of the slots in the warehouse are equally likely to be used. The pallets can be stacked six-high. The warehouse will have a rectangular shape with a single I/O point located along its perimeter. The investment costs for the building are $5.00 per square foot of area (with no perimeter costs), and will have a salvage value equal to 100% of its original cost at the end of 15 years. The area needed for cross aisles, offices, and shipping/receiving docks equals approximately 15% of the total storage area in the warehouse. Two types of trucks are being considered for all storage and retrieval operations: standup counterbalanced (UCBs) and narrow-aisle reach (NAR) trucks. Each UCB and NAR requires 12- and 8-foot-wide down aisles, respectively, requires 25 and 35 seconds for loading or unloading, respectively, has an investment cost of $25,000 and $30,000, respectively, and will have a salvage value equal to 25% of its original cost at the end of 15 years. Riding speed is 7 mph (5,280 ft/mile) and fuel cost is $2.00 per hour of operation. The fully burdened labor rate of a truck operator is $12.00 per hour. The number of operators is equal to the number of trucks and each operator is paid for an entire shift. If there are 250 eight-hour shifts per year and the real cost of capital is 10% per year with annual compounding, determine which type of truck should be selected assuming an expected annual demand of 500,000 single-command moves and enough trucks and operators to handle peak loads that are 25% above the average demand rate. In order to minimize maintenance costs, only a single type of truck will be selected. All additional costs (e.g., maintenance, administrative, site, and utility costs, etc.) can be ignored. (*Answer:* UCB TC = $780,149/yr < NAR TC = $782,652/yr $\Rightarrow$ UCB selected)

25. A new public warehouse is being designed. It is expected to store 4,800 different items, and each item can be assumed to belong to a different customer of the warehouse. The average maximum inventory level of each item is two hundred and fifty units, six percent of which is safety stock. The average unit cost of each item in storage is $46.75, and is expected to increase 3% per year for each of the next ten years. Randomized block stacking will be used to store 40 × 42 × 42 in. two-way pallet loads, one unit per pallet, and all of the slots in the warehouse are equally likely to be used. There is no limit on stacking pallets, but the clear height available for stacking is 18 feet. The warehouse will have a rectangular shape with a single I/O point located along its perimeter. The investment costs for the building are $15.50 per square foot of area, and it will have a salvage value equal to 100% of its original cost at the end of ten years. The area required for cross aisles, offices, and shipping/receiving docks equals 15% of the total storage area. A narrow-aisle reach truck will be used for all storage and retrieval operations. Each truck requires seven-foot-wide down aisles, requires 35 seconds for loading or unloading, has an investment cost of $35,000, and will have a salvage value equal to 25% of its original cost at the end of ten years. Riding speed is 7 mph and fuel cost is $2.75 per hour of operation. The fully burdened labor rate of all direct labor is $15.00 per hour. One operator is assigned to each truck for an entire shift, and there are twelve additional workers that perform the other move-related tasks. The annual demand is expected to be constant at two-million single-command moves. There should be enough trucks to handle a peak loads that are 25% above the average demand rate. If there are two eight-hour shifts per day, five days a week, fifty weeks per year and the real cost of capital is 5% per year with annual compounding, what is the minimum cost that can be charged for (a) each single-command move and (b) the time each pallet load spends in the warehouse? Also, (c) what are other costs that should be added to each charge to better reflect the true costs of each activity? (*Answer:* (a) $2.10 per move, (b) $2.70 per slot-year, (c) most significant missing costs are the facility non-move-related operating costs, which should be added to the slot-year charge)

26. The inventory levels of the products A, B, and C are listed in the table below. How many storage locations are required if a dedicated storage policy is used? How many locations are required if a randomized policy is used? How many are required if a class-based policy is used where Products A and C together form Class I and Product B forms Class II? (*Answer:* Dedicated = 15 + 20 + 18 = 53 locations, Randomized = 36 locations, Class-based = 26 + 20 = 46 locations)

	Product		
Period	A	B	C
1	10	12	7
2	8	9	8
3	9	20	7
4	15	8	3
5	11	5	2
6	8	2	18

27. Consider the storage area shown below. The I/O port is used for all S/R operations. Products A, B, and C each require 8, 4, and 12 slots, respectively, and have throughput requirements of 25, 13, and 38. Use the DSAP to determine the slot assignments for each product that minimizes the total distance traveled (label the product assigned to each slot). You can assume Assumptions 1–4 of DSAP are satisfied and that the same material handling equipment is used for all S/R operations. Rectilinear travel is used and is measured between the centroids of the slots and the I/O port.

						I/O						

(*Answer:* Given flow densities of 3.125, 3.25, and 3.167 for A, B, and C, respectively:)

						A						
					A	C	A					
				A	C	C	C	A				
			A	C	C	B	C	C	A			
		C	C	B	B	I/O	B	C	C	A		