b. In an attempt to stem the flow of jobs overseas, the local labor union has negotiated a penalty clause for layoffs. The new contract increases the firing cost per worker to $2500. Create a revised aggregate plan with these new cost figures. Assuming any subcontracting is, in fact, foreign production, does the penalty work? Why or why not?

Month	Demand
Jan	500
Feb	500
Mar	1000
Apr	1200
May	2000
Jun	400
July	400
Aug	1000
Sept	1000
Oct	1500
Nov	7000
Dec	500

13-8. Midlife Shoes, Inc. is a manufacturer of sensible shoes for aging baby-boomers. The company is having great success, and although demand is seasonal, it is expected to increase steadily over the next few years. The company is purchasing a new facility to accommodate the increase in demand, but the facility will not open until 13 months from now. The current facility can only accommodate 15 workers. Hiring and firing costs are negligible. Using the information below, help Midlife manage this transition year by deriving a production plan that will meet demand at the lowest cost.

Month	Demand
Jan	1000
Feb	1200
Mar	1200
Apr	3000
May	3000
Jun	3000
Jul	2200
Aug	2200
Sep	4000
Oct	4000
Nov	2200
Dec	3000

Beginning inventory	0 units
Beginning workforce	8 workers
Production rate	100 units per worker per month
Regular capacity	Maximum of 15 workers
Overtime capacity	Half of regular production
Subcontracting capacity	1000 units
Regular production cost	$36 per unit
Overtime production cost	$54 per unit
Subcontracting cost	$70 per unit
Inventory holding cost	$10 per unit

13-14. The Wetski Water Ski Company is the world's largest producer of water skis. As you might suspect, water skis exhibit a highly seasonal demand pattern, with peaks during the summer months and valleys during the winter months. Given the following costs and quarterly sales forecasts, use the transportation method to design a production plan that will economically meet demand. What is the cost of the plan?

Quarter	Sales Forecast
1	50,000
2	150,000
3	200,000
4	52,000

Inventory carrying cost	$3.00 per pair of skis per quarter
Production per employee	1000 pairs of skis per quarter
Regular workforce	50 workers
Overtime capacity	50,000 pairs of skis
Subcontracting capacity	40,000 pairs of skis
Cost of regular production	$50 per pair of skis
Cost of overtime production	$75 per pair of skis
Cost of subcontracting	$85 per pair of skis

13-15. College Press publishes textbooks for the college market. The demand for college textbooks is high during the beginning of each semester and then tapers off during the semester. The unavailability of books can cause a professor to switch adoptions, but the cost of storing books and their rapid obsolescence must also be considered. Given the demand and cost factors shown here, use the transportation method to design an aggregate production plan for College Press that will economically meet demand. What is the cost of the production plan?

Months	Demand Forecast
February–April	5,000
May–July	10,000
August–October	30,000
November–January	25,000

Regular capacity per quarter	10,000 books
Overtime capacity per quarter	5,000 books
Subcontracting capacity per qtr	10,000 books
Regular production rate	$20 per book
Overtime wage rate	$30 per book
Subcontracting cost	$35 per book
Holding cost	$2.00 per book

13-16. Bits and Pieces uses overtime, inventory, and subcontracting to absorb fluctuations in demand. An annual production plan is devised and updated quarterly. Expected demand over the next four quarters is 600, 800, 1600, and 1900 units, respectively. The capacity for regular production is 1000 units per quarter with an overtime capacity of 100 units a quarter. Subcontracting is limited to 500 units a quarter. Regular production costs $20 per unit, overtime $25 per unit, and subcontracting $30 per unit. Inventory holding costs are assessed at $3 per unit per period. There is no beginning inventory. Design a production plan that will satisfy demand at minimum cost.

13-1. Bioway, Inc., a manufacturer of medical supplies, uses aggregate planning to set labor and inventory levels for the year. While a variety of items are produced, a standard kit composed of basic supplies is used for planning purposes. Demand varies with seasonal illnesses and the quarterly ordering policies of hospitals. The average worker at Bioway can produce 1000 kits a month at a cost of $9 per kit during regular production hours and $10 a kit during overtime production. Completed kits can also be purchased from outside suppliers at $12 each. Inventory carrying costs are $2 per kit per month. Overtime is limited to regular production, but subcontracting is unlimited. Due to high quality standards and extensive training, hiring and firing costs are $1500 per worker. Bioway currently employs 25 workers. Given the demand forecast below, develop a six-month aggregate production plan for Bioway using (a) a pure strategy, and (b) a mixed strategy.

Month	Demand
April	60,000
May	22,000
June	15,000
July	46,000
August	80,000
September	15,000

13-2. Paul's Produce ships fresh fruit from its Florida distribution center to households across the country. Demand varies significantly during the year with peaks in the fall and winter months when local fruits and vegetables are typically not available. The average demand for fruit is 1000 cases in the spring, 3500 cases during the summer months, 4500 cases in the fall, and 9250 cases in the winter. No inventory is held since fruit is highly perishable. Paul needs to know how many workers he should hire, how much overtime he should use, and how many units he should subcontract. He has gathered the following information to help in the analysis: Each worker can pack an average of 100 boxes per period at a cost of $0.50 per box under regular production. Overtime production costs $0.70 per box and is limited to regular production. Subcontracting is unlimited at $1.00 per box. The cost to hire or fire a worker is $50. Paul currently employs 10 workers.

a. Design a fulfillment plan for Paul and calculate the cost of the plan.
b. How would the plan change if hiring and firing costs increased to $300?

13-3. Rowley Apparel, manufacturer of the famous "Race-A-Rama" swimwear line, needs help planning production for next year. Demand for swimwear follows a seasonal pattern, as shown here. Given the following costs and demand forecasts, test these four strategies for meeting demand: (a) level production with overtime and subcontracting, as needed, (b) level production with backorders as needed, (c) chase demand, and (d) 3000 units regular production from April through September and as much regular, overtime, and subcontracting production in the other months as needed to meet annual demand. Determine the cost of each strategy. Which strategy would you recommend?

Month	Demand Forecast
January	1000
February	500
March	500
April	2000
May	3000
June	4000
July	5000
August	3000
September	1000
October	500
November	500
December	3000

Beginning workforce	8 workers
Subcontracting capacity	unlimited
Overtime capacity	2000 units/month
Production rate per worker	250 units/month
Regular wage rate	$15 per unit
Overtime wage rate	$25 per unit
Subcontracting cost	$30 per unit
Hiring cost	$100 per worker
Firing cost	$200 per worker
Holding cost	$0.50 per unit/month
Backordering cost	$10 per unit/month

13-4. Mama's Stuffin' is a popular food item during the fall and winter months, but it is marginal in the spring and summer. Use the following demand forecasts and costs to determine which of the following production planning strategies is best for Mama's Stuffin':

a. Level production over the 12 months.
b. Produce to meet demand each month. Absorb variations in demand by changing the size of the workforce.

c. Keep the workforce at its current level. Supplement with overtime and subcontracting as necessary.

Month	Demand Forecast
March	2000
April	1000
May	1000
June	1000
July	1000
August	1500
September	2500
October	3000
November	9000
December	7000
January	4000
February	3000

Overtime capacity per month	regular production
Subcontracting capacity per month	unlimited
Regular production cost	$30 per pallet
Overtime production cost	$40 per pallet
Subcontracting cost	$50 per pallet
Holding cost	$2 per pallet
Beginning workforce	10 workers
Production rate	200 pallets per worker per month
Hiring cost	$5000 per worker
Firing cost	$8000 per worker

13-5. FansForYou is a small, privately owned company that manufactures fans. Large variations in demand due to seasonality have contributed to high costs for the company. FansForYou currently uses a level production strategy because it prefers not to hire and fire employees. However, if there is enough cost justification, the company will consider alternative production plans.

a. What is the cost of the current production plan?
b. How much would FansForYou save by using a chase demand strategy?
c. How much would FansForYou save by keeping a steady workforce of 20 workers and supplementing with overtime and subcontracting as needed?

Month	Demand
Sep	1500
Oct	1000
Nov	600
Dec	600
Jan	600
Feb	800
Mar	1000
Apr	1000
May	4000
Jun	6500
Jul	6000
Aug	4000

Beginning inventory	0
Beginning workforce	25 workers
Production rate	100 fans per worker per month
Regular production cost	$40 per fan
Overtime production cost	$60 per fan
Subcontracting cost	$70 per fan
Overtime capacity	Not to exceed regular production
Subcontracting capacity	Unlimited
Holding cost	$8 per fan
Hiring cost	$2000
Firing cost	$3000

13-6. Slopes & Sleds (S&S) makes skis, snowboards, and high-end sledding equipment. As shown below, the demand for its products is highly seasonal. The company employs 10 workers who can each produce 200 units of various equipment per month. The cost of regular production is $8 per unit, overtime $12, and subcontracting $16. Overtime is limited to regular production each period. Hiring and firing costs are $500 per worker. Inventory holding costs are $2 per unit per month. Given the estimates of demand below, create an aggregate production plan for Slopes & Sleds using:

a. the current workforce level (supplemented with overtime and subcontracting as needed),
b. chase demand.

Month	Demand
Jan	6400
Feb	7000
Mar	1500
Apr	500
May	600
Jun	1400
July	1600
Aug	2000
Sept	1400
Oct	1500
Nov	5200
Dec	6900

13-7. Sawyer Furniture is one of the few remaining domestic manufacturers of wood furniture. In the current competitive environment, cost containment is the key to its continued survival. Demand for furniture follows a seasonal demand pattern with increased sales in the summer and fall months, culminating with peak demand in November.

a. The cost of production is $16 per unit for regular production, $24 for overtime, and $33 for subcontracting. Hiring and firing costs are $500 per worker. Inventory holding costs are $20 per unit per month. There is no beginning inventory. Ten workers are currently employed. Each worker can produce 50 pieces of furniture per month. Overtime cannot exceed regular production. Given the following demand data, design an aggregate production plan for Sawyer Furniture that will meet demand at the lowest possible cost.