

## **Operations of manufacturing systems**

#### <u>Sheet # 1</u>

## (Just-in-time (JIT))

**Problem # 1.** Calculate the number of Kanbans needed at the ABC company for the following two products, produced in a factory that works eight hours per day, five days per week.

	Product 1	Product 2
Usage	300/week	150/day
Lead time	1 week	2 week
Container size	20 units	30 units
Safety stock	15 percent	0

Solution:

Variable	Product 1	Product 2	
Daily Demand (D)	$\frac{300}{5}$	150	
Lead Time (L)	5 days	10 days	
Safety Stock (SS) , $\alpha$	15%	0	
EOQ	20	30	
# of Kanbans= $\frac{D.L(1+\alpha)}{EOQ}$	17.25 ≈18 Cards	50 Cards	
Total number of kanbans in the system	18+50=68 Cards		

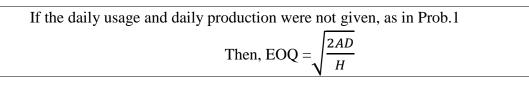
**Problem # 2.** Krupp Refrigeration, Inc., is trying to reduce inventory and wants to install a Kanban system for compressors one of its assembly lines. Determine the **SiZe** of containers and **number** of Kanban cards (number of containers) needed, given the following data: Setup cost = \$10Annual holding cost per compressor = \$100Daily production = 200 compressors Annual usage = 25,000 (50 weeks x 5 days each x daily usage of 100 compressor) Lead time = 3 days

Safety stock = 1/2 day's production of compressors

Solution:

1- **size** of containers(EOQ) = 
$$\sqrt{\frac{2AD}{H*(1-\frac{Daily\,usage}{Daily\,production})}} = \sqrt{\frac{2*10*25,000}{100*(1-\frac{100}{200})}}$$

=100units



2- # of kanbans = ?

Here, we should note that the Safety stock given to us as half of the <u>daily production</u> (Not same as **Problem # 1**)

# of kanbans = 
$$\frac{D.L+SS}{EOQ} = \frac{100*3+0.5*200}{100} = 4 Cards$$

**Problem # 3.** The DEF Company produces three products using a mixed-model assembly line, which is operated 16 hours per day (2 shifts of 8 hours each) for 250 days per year. The annual demand forecasts for the products are as follows:

Product	Forecasts
1	20,000
2	10,000
3	5,000

- a. Determine a mixed-model master production schedule for a daily batch, based on minimum batch size for each product.
- b. Prepare a daily schedule indicating the **number** of each product to be produced each day.
- c. Product 1 requires 2 units of component A and one unit of component B. If component A is manufactured internally at DEF, how many kanbans would be required for this component if the lead time is 2 days, the safety factor is 15 percent, and the container size is 25 units?

## Solution:

a. A mixed-model master production schedule (MPS) for a daily batch, based on minimum batch size for each product:

	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
Daily batch MPS	$\frac{20,000}{20,000} = 80$	40	20
(Minimum)	$\frac{1}{250} - 80$	40	20

b. A daily schedule indicating the number of each product to be produced each day: This means the mixed model final assembly schedule (FAS) FAS must be prepared according to the proportion of each product: 80, 40, 20. This is equivalent to *proportion of 4, 2, 1*. Now FAS should be as follows:

**1 2 1 2 1 3 1**.....this schedule should be repeated **20 times daily** 

**Note**: in case of large change over costs between products, the following schedule can be used:

**1 1 1 1 2 2 3**.... this schedule should be repeated again 20 times daily

c. Product 1 requires 2 units of component A and one unit of component B. If component A is manufactured internally at DEF, how many kanbans would be required for this component if the lead time is 2 days, the safety factor is 15 percent, and the container size is 25 units?

The number of kanbans required for component A: The daily demand of A = 80 x 2 = 160 Container capacity (CC) = 25 units Lead time = 2 days Safetey stock percent ( $\alpha$ ) = 15% Number of Kanbans of component A =  $\frac{DL(1+\alpha)}{CC}$ =  $\frac{160 x 2 (1.15)}{25}$  = 17.42 = 15 kanban cards

**Problem # 4**. The EFG Company works an 8-hour/day, 250-day/year schedule, producing four models with the following annual demand forecast:

Product	Forecasts
Ι	500
II	1,500
III	4,500
IV	6,000

a. A mixed-model minimum batch Master Production Schedule for EFG, based on a daily batch and an hourly batch:

	P <sub>1</sub>	P <sub>2</sub>	<b>P</b> <sub>3</sub>	$P_4$
Daily batch MPS	$\frac{500}{250} = 2$	6	18	24
(Minimum)	$\frac{1}{250}$ – 2	0	10	24
Hourly batch	2			
MPS	$\frac{2}{2} = 0.25$	0.75	2.25	3
(Minimum)	8			

b. A detailed mixed-model schedule for an eight-hour day using minimum batch sizes:

The **mixed-model schedule** (**FAS**) for a day is made according to the proportion of the products daily quantities:

2, 6, 18, 24 equivalent to 1, 3, 9, 12

The mixed model schedule should be:

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....this schedule should be repeated **twice** each day during the 8 hours in order to have smooth, level production, and to satisfy annual forecast.

**Note**: in case of large change over costs between products, the following schedule can be used:

**444444444443333333332221**.... this schedule should be repeated again 2 times daily.