



King Saud University
Department of Industrial Engineering
IE-434 Reliability and Maintenance Engineering
Second Midterm Exam - Duration 90 min
Sun 15th of May, 2011; 12th of Jumada Al-Thani,
1432



Student Name :

Student Number :

Section : Dr.

Question 1 :/10

Question 2 :/45

Question 3 :/45

Total :/100

Question 1 (10 Points)

For the following statements, put check sign (√) for the correct statement and cross sign (X) for the wrong statement:

1. The sum of maintenance load in planned maintenance works and unplanned maintenance works is fixed and known quantity. 1-()
2. Delphi method is one of the qualitative techniques which us used to forecast the maintenance load. 2-()
3. The time horizon is not an important factor when selecting the forecasting techniques 3-()
4. Seasonal forecasting is one type of forecasting techniques which us used for the data that follows cyclic pattern, and repeats itself every N periods 4-()
5. Moving average is a series of arithmetic means which is used if there is little or no trend and often for smoothing 5-()
6. Maintenance capacity planning is performed to determine optimal level of maintenance demand required to meet the forecasted maintenance load 6-()
7. In the chase strategy for capacity planning, the peaks of demand are distributed to periods of lower demand, aiming to have a constant level of monthly maintenance activity. 7-()
8. The three sources of craftsmen are; Regular workers, Overtime in-house workers and Contract maintenance workers. 8-()
9. In deterministic models of capacity planning, the forecasted maintenance load is random variables with certain probability distributions 9-()
10. Heuristic tableau method is a deterministic models for maintenance capacity planning 10-()

Question 2 (45 Points)

The maintenance department in an automotive assembly plant is supporting three-shift operation. Because of low demand on car sales the plant had to run two-shift operation and temporary layoff part of its workers during the months of June, July and August of 2009. The maintenance workload is listed in the following table

Month	Maintenance workload (man hours)
Mar-09	876
Apr-09	847
May-09	849
Jun-09	578
Jul-09	598
Aug-09	521
Sep-09	798
Oct-09	773
Nov-09	542
Dec-09	712
Jan-10	695
Feb-10	674
Mar-10	661

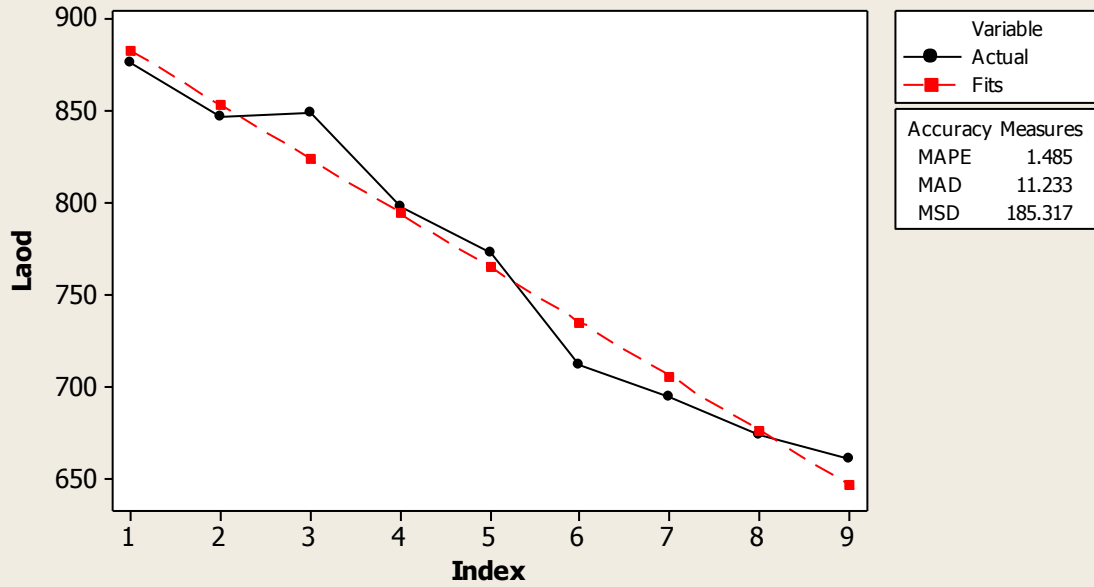
The maintenance manager discovered that data which was used to collect the maintenance workload in the month of Nov 2009 is corrupted and do not represent the actual workload.

1. If the plant planned to run three-shift operation from the month of April 2010 until the end of 2010, forecast the maintenance workload for the months of April and May 2010 **(35 Points)**
2. If the actual maintenance load in the months of April and May 2010 were 645 and 553 man hours respectively, what type of measures (actions) the maintenance manager would take to satisfy the maintenance demand and better utilize the maintenance workforce? **(10 Points)**

Maintenance Load

Linear Trend Model

$$Y_t = 912.8 - 29.5500 * t$$



Question 3 (45 Points)

The required maintenance workload for the next four months in a food processing plant is 530, 380, 360, and 435 man-hours, respectively. The demand can be met by either regular time at a cost of SR 35 per hour, overtime at a cost of SR 50 per hour or subcontract at cost of SR85 per hour. Regular time capacities are listed following, overtime capacity cannot exceed 25% of regular time capacity at any month. Early maintenance costs extra SR 5 per hour per month, while late maintenance (backlog) costs extra SR 10 per hour per month. Subcontract hours are available but can only be purchased in 100-hour contract. (This means that you cannot use less than 100 hours of subcontract hours, increment of 100 hours)

Month	Regular Time Capacity (hours)
1	380
2	300
3	260
4	360

1. Using the heuristic tableau method, develop the capacity plan to satisfy the required workload **(30 Points)**
2. Calculate the total cost of the plan **(10 Points)**
3. If the subcontract hour can used without any constraints (any limit on the number of hours). How much that would save on the total cost of the plan? . **(5 Points)**

Periods	Period Sources	1	2	3	4	Capacity	
1	Regular Time	35				380	
							380
		380					
	Overtime	50				95	
							95
		95					
	Subcontract	85				100	
							100
		0					
2	Regular Time	45	35			300	
							300
		300					
	Overtime	60	50			75	
							75
		55	20				
	Subcontract	95	85			100	
							100
		100					
3	Regular Time		45	35	40	260	
							260
			260				
	Overtime		60	50	55	65	
							65
			60	5			
	Subcontract		95	85	90	100	
							100
			80	20			
4	Regular Time			45	35	360	
							360
	Overtime			60	50	90	
							90
				15	55		
	Subcontract			95	85	100	
							100
	Maintenance load	530	380	360	435		

Useful Formals

$$F_t = \frac{\sum_{i=1}^N D_{t-i}}{N}$$

$$F_t = \sum_{i=1}^N w_i D_{t-i}$$

$$\sum_{i=1}^N w_i = 1$$

$$F_t = \alpha D_{t-1} + (1 - \alpha) F_{t-1}$$

$$D_i = a + bt_i + \varepsilon_i$$

$$b = \frac{n \sum_{i=1}^n t_i D_i - \sum_{i=1}^n t_i \sum_{i=1}^n D_i}{n \sum_{i=1}^n t_i^2 - \left(\sum_{i=1}^n t_i \right)^2}$$

$$a = \frac{1}{n} \left(\sum_{i=1}^n D_i - b \sum_{i=1}^n t_i \right) = \bar{D} - b\bar{t}$$

$$D_t = c_t \mu + \varepsilon_t$$

$$\sum_{t=1}^N c_t = N$$

$$D_t = c_t(a + bt) + \varepsilon_t$$