

Assume any missing data

Please attempt all questions. No. of Questions: 4 No. of pages: 2

**Q1: (10 Marks)**

Tick (✓) or (X) in front of the following:-

1. RCFA is a proactive approach to minimize the number of failures. ( )
2. Policy is certain rules and program for long term. ( )
3. FMEA is the risk based-maintenance. ( )
4. BD is the breakdown maintenance. ( )
5. RCM is the keep system function and improve reliability. ( )
6. Advanced RCM is a risk-based tool for management of maintenance and inspection. ( )
7. Vibration analysis is the condition based maintenance. ( )
8. RTF is the time based maintenance. ( )
9. Productivity is resource utilization and efficiency. ( )
10. Maintenance management is a powerful systematic methodology to minimize the facility performance. ( )

**Q2: (15 Marks)**

- a) What is RCM? (2 Marks)
- b) Comparison between classical and streamlined RCM processes. (3 Marks)
- c) Explain system description and functional block diagram. (3 Marks)
- d) What is FMECA? (2 Marks)
- e) Discuss RCM principles. (3 Marks)
- f) Explain benefits of RCM? (2 Marks)

**Q3: (15 Marks)**

- a) In Electric Motor Company, system information for motor manufacturing processes is as follows.

	Machines	Process	Safety	Standby
1	Cutting M/C	major	medium	with
2	Hydraulic press	major	major	with
3	Pneumatic press	major	major	with
4	Eccentric press	major	major	with
5	Drilling M/C	medium	minor	with
6	Threading M/C	medium	minor	without
7	Turning M/C	major	minor	with
8	Spot welding M/C	medium	major	without
9	Electric welding M/C	medium	major	without
10	Grinding	medium	major	without
11	Cleaning	medium	minor	with
12	Painting M/C	medium	minor	without
14	Rolling	major	major	with

Required:

1. Algorithm for the calculation of machines criticality. (3 Marks)
2. Criticality for machines. (3 Marks)

3. Criticality group for machines.

(3 Marks)

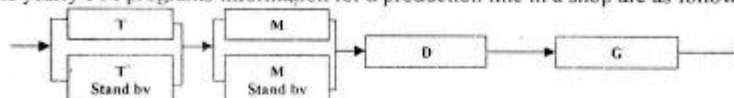
b) Assume that in a maintenance organization we have the following data:

- Total number of annual hours (TAH) = 2000 h
- Benefit ratio (BR) = 0.2
- Hourly labor rate (LR) = \$15/hour
- Number of employees (N) = 40

Calculating the total labor cost associated with the maintenance activity by inserting the above values into Eqn. ( $C_{em} = LR (1 + BR)TAH$ ) where,  $C_{em}$  = cost per employee.

**Q4: (30 Marks)**

The yearly PM programs information for a production line in a shop are as follows:



M/c Type	No .of Machines	Down Time CM (day/year)	PM levels per Machine					
			10 days		6 monthly		yearly	
			Man	Day	Man	Day	Man	Day
Turning	2	24	2	1	4	2	5	4
Milling	2	16	2	1	-	-	4	3
Drilling	1	10	1	1	2	2	-	-
Grinding	1	8	-	-	3	2	3	3

M/c Type	PM Spar parts and materials cost (L.E)		
	10 days	6 monthly	yearly
Turning	300	1000	2000
Milling	600	-	4000
Drilling	500	1600	-
Grinding	-	1000	2000

**Working conditions:**

- Production & maintenance 52 week/year, 6 day/week, 8hours/day
- Manpower 45 week/year, 6day/week, one shift
- Average labor rate is 15 L.E/man-hour
- Average other costs are 25 % direct maintenance cost
- Average CM spare parts costs are 15% PM spare parts costs
- Average CM manpower is 30% PM manpower
- Average down time cost rate is 100 L.E/machine-hour

**Required:-**

1. Mathematical model formulation. (5 Marks)
2. The size of maintenance labor force. (4 Marks)
3. Annual maintenance cost. (3 Marks)
4. Average downtime for each machine type. (3 Marks)
5. Average system availability. (4 Marks)
6. Average down time cost for each machine type. (3 Marks)
7. Annual maintenance plan. (4 Marks)
8. Maintenance resource profile. (4 Marks)

Good Luck  
Dr. Islam H