Max. Marks 80

Date: 24th November 2015 (Tuesday)
Time: **2 Hrs.**
Note: 1. Attempt all questions
2. Missing data, if any, may be assumed suitably. In addition, suitable assumption may be considered, if required.

Q1. a) Differentiate the following:
  i)   Overhaul, Repair and Replacement
  ii) Plant Administrative Structure for Maintenance – Traditional and Progressive.
  iii) Fault tree and Maintenance tree.
  iv) Human errors - 'Performance of a forbidden action', and 'Carrying out an incorrect task', with an example each

  b) Describe role of 'Control' in plant maintenance.   **(6, 6, 6, 4, 8= 30)**

Q II. a) Determine, if the optimal maintenance policy (Overhaul, replace and repair) decisions are obtained for infinite time origin and if so, what is the average cost per period for a production equipment by using Howard's algorithm steps for two iterations. The relevant data for the equipment is given in Table 1.

Table 1

Condition at start of period	Decision	Condition at the end of period		Expected Cost
		Good	Failed	
Good	Overhaul	0.70	0.30	Rs. 4000
	Replace	0.85	0.15	Rs. 5500
Failed	Repair	0.65	0.35	Rs. 4500
	Replace	0.85	0.15	Rs. 5500

  b) A Chemical manufacturing corporate has been collecting data of its plants to evaluate the performance of its maintenance department as per Du Pont Method. Table 2 data is of its Vishakhapatnam plant for cost function for the previous year, including future goal. Evaluate and comment on the performance of the department for the cost function for the previous year with future goal for Vishakhapatnam plant.

Table 2

Function	Factor	Previous Year	Future Goal
Cost (CT)	CT1: Maintenance cost as a % of plant investment	10.5%	6. 0%
	CT2: % increase or decrease in maintenance cost per unit of product produced over a base period	+ 15%	- 9%
	CT3: % of total maintenance $ cost for direct and general maintenance	65%	85%
	CT4: % of total maintenance $ cost for indirect maintenance	45%	25%

(12, 6= 18)

Q III. a) Refer Fig. 1 for the network showing activity durations and associated resource loading for a major maintenance work in a production plant. Answer the following:
  i) Prepare a histogram of the earliest start aggregation of the resource utilization. Splitting of the activities is permitted.
  ii) Although for this work, plant manager has made available 4 fitters each day in the second shift, yet it will be better to manage this work with reduced manning availability in view of the workload. Find out in how many days this work will be completed, if resource availability is as assigned, i.e. 4 fitters, and one less than assigned, i.e. 3 fitters.

  b) An automobile braking system consists of a fluid braking subsystem (foot brake) and a mechanical braking subsystem (parking brake). Both subsystems must fail in order for the system to fail. The fluid braking subsystem will fail if master cylinder or hydraulic line fails (event M) or all four wheel braking units fail. A wheel braking unit will fail if either the wheel cylinder fails (events WC1, WC2, WC3, WC4) or brake pad, BP, assembly fails (events BP3, BP4). The mechanical braking system will fail if the cable system fails (event C) or both rear brake pad assemblies fail (events BP3, BP4). Fault tree diagram for barking system failure to stop the automobile is constructed, which is shown in Fig. 2. Answer the following:
  i)   Find minimal cut-sets of the tree diagram.
  ii) Develop maintenance tree diagram for mechanical brake failure (parking brake).
  iii) List two failure modes each for two units or components of brake system of your choice.

c) A 3-shift production plant is operating 7days a week. Time allowed for change of tools, product, change of shifts, etc. is 3 Hrs. per day. During the second six-month period (October – March) of the last financial year, down time of production equipment resulted in 164 maintenance actions. Assess the equipment down time for the second half of the year if the production availability is 80%. What is the MTBF of the equipment?
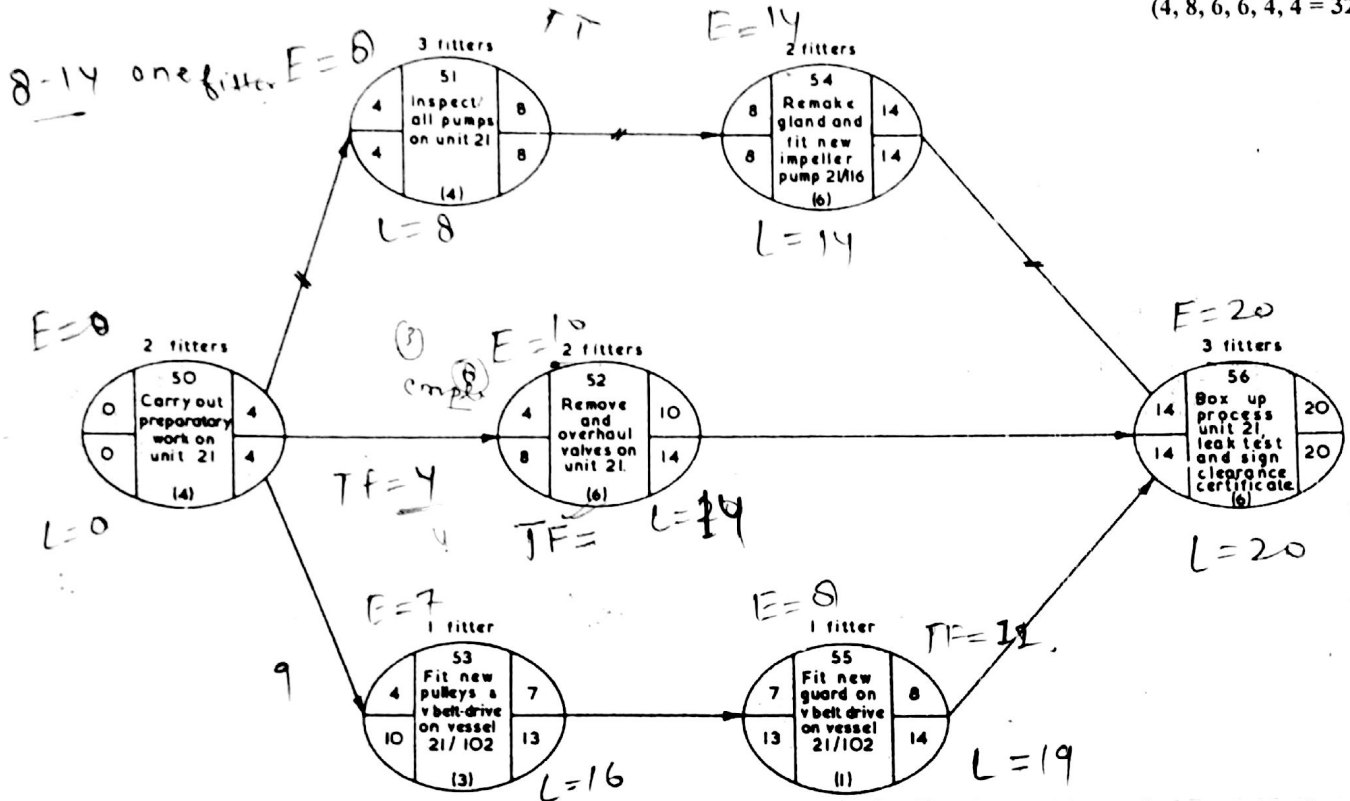
(4, 8, 6, 6, 4, 4 = 32)

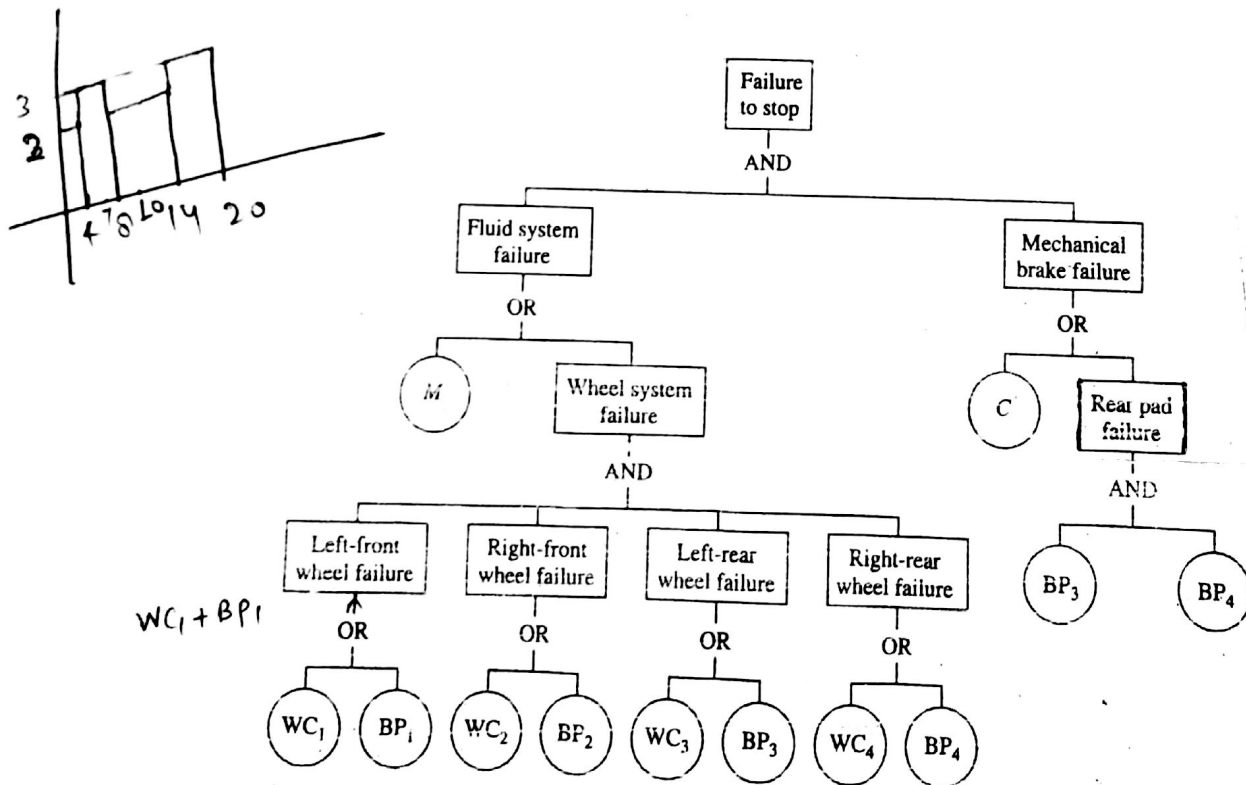Fig. 1 Network showing activity durations and associated resource loading for a major maintenance work

Fig. 2 Fault tree for the automotive braking system