⇒

Q2 (a) $i \rightarrow$ sites 1, 2 .. 5

$j \rightarrow$ states 1, 2 .. 8

$x_{ij} = \begin{cases} 1 \\ 0 \end{cases}$ amount of site i in state j

$y_i = \begin{cases} 1 \\ 0 \end{cases}$ if site open or not

$$\min \sum_{i \in I} (fc_i y_i) + \sum_{j \in J} \sum_{i \in I} c_{ij} x_{ij}$$

$$x_{ij} \leq (y_i) M \quad \forall i, j, \quad \sum_{i \in I} x_{ij} = d_j \quad \forall j$$

(c) $a_{ij} = \begin{cases} 1 \rightarrow \text{if } i \text{ state in state } j \\ 0 \end{cases}$

$\sum_{j=J} a_{ij} = 2 \cdot y_i$ each site serve 2 state for site that exists

$\sum_{i=I} a_{ij} = 1$ each state only 1 site

(Added D.V) Constraint

If x_{ij} not 0, only then $a_{ij} \neq 0$

$$a_{ij} \leq x_{ij}$$

Q3: 8 emp, 3 shift, 7 days.

(a)

X_{ijk} → 1: i^{th} emp, at j^{th} shift on k^{th} day.
0

one shift/day

① $\sum_{j \in J} X_{ijk} \leq 1 \quad \forall i \in I, k \in K$

② $\sum_{k \in K} \sum_{i \in I} X_{ijk} = 1 \quad \forall j \in J$, each shift only 1 emp.

$\max \sum_{j \in J} \sum_{i \in I} P_{ij} X_{ij}$

② $j=1$

$X_{111} + X_{211} + X_{311} \cdots = 1$

① $X_{111} + X_{121} + X_{131} \leq 1$

(c) $X_{111} + X_{121} + X_{131} + X_{112} + X_{122} + X_{123} \cdots$

$X_{17} \leq 3$

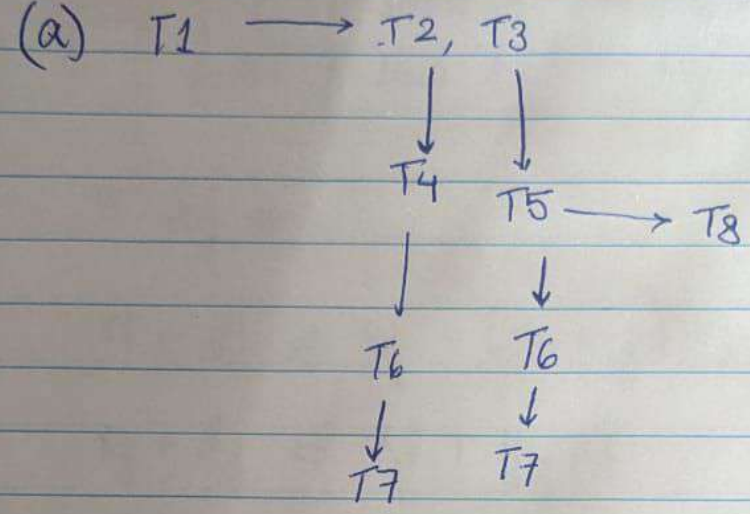
$\sum_{k=1}^{7} \sum_{j=1}^{3} X_{ijk} \leq 3 \quad \forall i \in I$ (8)

$\sum_{k} \left(X_{i3k} + X_{i1(k+1)} \right) \leq 1 \quad \forall i, k = 1 \cdots 6$

$i = T_1 .. T_8$

$x_i \Rightarrow$ start time of task i

Q4. (a)



A are → (T_1, T_2) (T_1, T_3) (T_2, T_4) $\cdots$ (T_5, T_8)
(i, j)

$$x_i + d_i \leq x_j \quad \forall (i,j) \in A$$

$$\min \; (x_8 + d_8) + \sum_{i=1}^{8} (x_i + d_i) p_i$$

T_{max}

$$T_{max} \geq x_i + d_i \quad \forall i$$

(c) $x_{ij} \Rightarrow$ 1 i starts before j Task
0 j starts before i
send
end

M: big number.

$$x_i + d_i \geq (x_j + d_j)(1 - y_{ij}) M$$

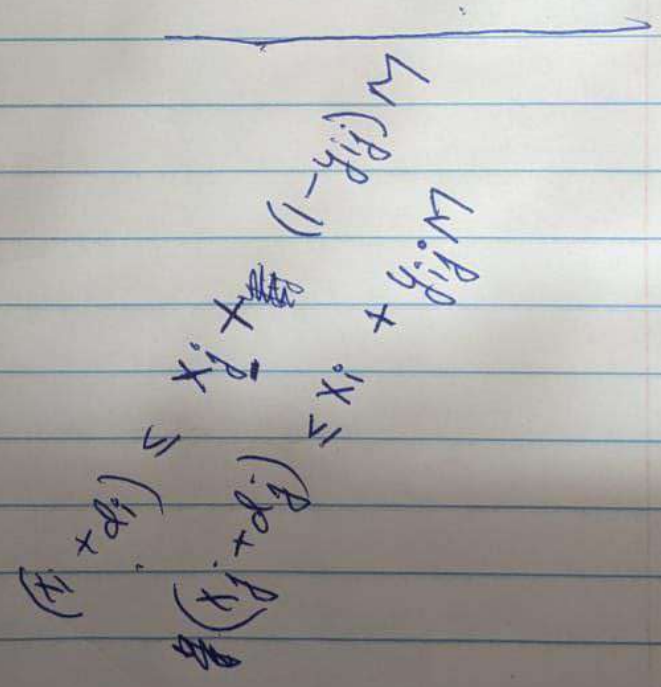
$$x_i + d_i \leq (x_j + d_j) y_{ij} M$$

(c) $y_{ij} = \begin{cases} 1 & i \text{ starts \& ends before } j \\ 0 & j \text{ starts \& ends before } i \end{cases}$

M: big no.

$x_i + d_i \leq x_j + (1 - y_{ij})\, M$

$x_j + d_j \leq x_i + y_{ij} M$



$y_{ij} = 0$

$x_i + d_i \leq M$

$x_j + d_j \leq x_i$

$y_{ij} = 1$

$x_i + d_i \leq x_j$

$x_j + d_j \leq M$