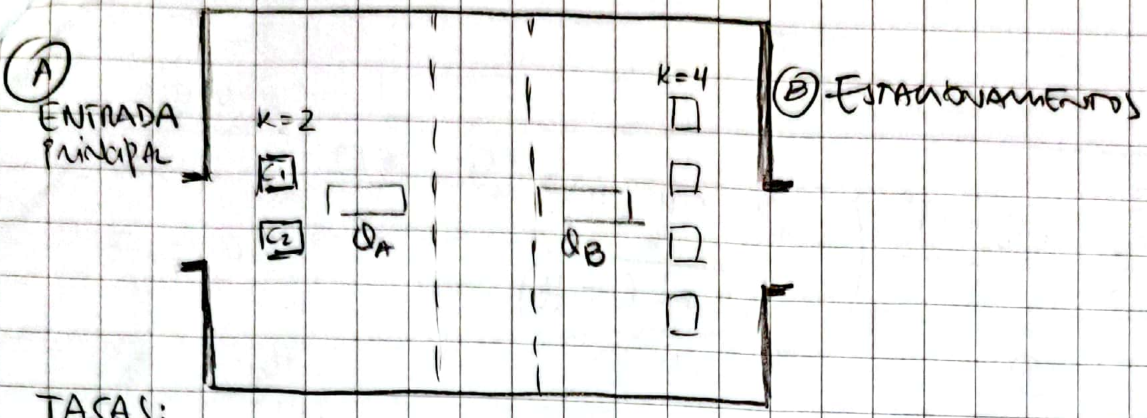
permercado:



TASAS:

$$\frac{1}{\mu} = 2.5\,[min] \longrightarrow \mu_i = \frac{1}{2.5\,[min]} \cdot \frac{60\,[min]}{1\,[hr]} = 24\,[c/h]$$

$$\lambda_B = 66\,[c/h]$$

$$\lambda_A = 20\,[c/h]$$

Est. Estacionario:

$$\rho_A = \frac{20}{2 * 24} = \frac{5}{12} \qquad \rho_B = \frac{66}{4 * 24} = \frac{11}{16}$$

1.1

A

$$P_0 = \frac{1}{\underbrace{\left[\sum_{n=0}^{0} \frac{(2\rho)^n}{n!}\right]}_{*} + \underbrace{\frac{(2\rho)^1}{1!\,(1-\rho)}}_{**}} = \frac{1}{1 + \frac{10}{7}} = \frac{7}{17} = \boxed{0.41176}$$

$$* = (2\rho)^0 = 1$$

$$** = \frac{10}{\cancel{12}} * \frac{\cancel{12}}{7} = \frac{10}{7}$$

$$L_q = \frac{\left(\frac{5}{12}\right)^3 * 2^1}{1! \cdot \left(\frac{7}{12}\right)^2} * \frac{7}{17} = \frac{5^3}{12^{\cancel{3}\,1}} * 2 * \frac{\cancel{12^2}}{7^{\cancel{2}}} * \frac{\cancel{7}}{17} = 0{,}175 \sim \boxed{0.18}$$

$$= \frac{125}{714}$$

$$W_{q_A} = \frac{\frac{125}{714}}{20} = \boxed{0.53\,[min]}$$

1

(B) $\rho_B = \frac{11}{16}$ $k = 4$

$$P_0 = \frac{1}{\underbrace{\left[\sum_{n=0}^{2} \frac{\left(\frac{11}{16}*4\right)^n}{n!}\right]}_{*} + \underbrace{\frac{\left(\frac{11}{16}*4\right)^3}{3!\left(1-\frac{11}{16}\right)}}_{**}} = \frac{1}{16.62} = \frac{480}{8939} = 0.05370$$

$$* = 1 + \left(\frac{11}{4}\right)^1 + \frac{\left(\frac{11}{4}\right)^2}{2} = 7.53125 = \frac{241}{32}$$

$$** = \frac{\left(\frac{11}{4}\right)^3}{3*2*\frac{5}{16}} = 11.09167 = \frac{1331}{120}$$

$$L_q = \frac{\left(\frac{11}{16}\right)^5 * 4^3}{3*2*\left(\frac{5}{16}\right)^2} * \frac{480}{8939}$$

$$= \frac{11^5 * 4^3 * \cancel{16^2} * \cancel{480}^{80}}{16^{\cancel{5}3} * \cancel{3*2} * 5^2 * 8939} = 0.90 = \frac{9}{10}$$

$$W_q = \frac{\frac{9}{10}}{66} = 0.0136\ [h] = \boxed{0.81\ [min]}$$

(1.2) $L_{s_A} = L_{q_A} + \rho_A k = \frac{125}{714} + 2 * \frac{5}{12} = \frac{120}{119} \sim \boxed{1}$ [pers]

$L_{s_B} = L_{q_B} + \rho_B \cdot k = \frac{9}{10} + \frac{11}{16} * 4 = \frac{73}{20} = 3.65 \sim \boxed{4}$ [pers]

Para que $Lq_B = 2$, deben haber 6 personas en el sistema.

$$P_n = \frac{\rho^n k^k}{k!} \cdot P_0 =$$

$$P_6 = \frac{\left(\frac{11}{16}\right)^6 \cdot 4^4}{4!} \cdot \frac{480}{8939} = \frac{11^6}{16^6} \cdot 4^4 \cdot \frac{1}{24} \cdot \frac{480}{8939} = \boxed{0.065}$$

720

$\boxed{6\%}$

(4) Debido a que los t son + o - similares
Depende de:
- si llego en auto → x salida
- sino → x entrada
-

(5)

(k=6)

$\lambda^* = 86$ [cl/h]

$\mu^* = 24$ [cl/h]

$C_{sueldo} = 16$ [US/h]

$C_{insat} = 20$ [US/h]

$C_{atendido} = 10$ [US/h]

$$\rho_{actual} = \frac{86}{6*24} = \frac{86}{144}$$

(*) Con un cajero (-):

$$\rho_{a-1} = \frac{86}{5*24} = \frac{43}{60}$$

$$\rho_{a-2} = \frac{86}{4*24} \approx 0.89 = \frac{43}{48}$$

$$\rho_{a-3} = \frac{86}{3*24} = 1.194 > 1 \therefore \text{no es estacionario!}$$

Sea $CT = \frac{1}{\mu} * C_{at} + Lq^* \times C_{ins} + k * C_{sueldo}$

$CT(\rho k)\ 0.4167 + Lq^* \cdot 20 + 16K$

Hay que determinar (k), para eso necesitamos saber $\boxed{Lq^*}$ en c/ k.

7

(3)

Con $k=4$: $\rho_{k=4} = \frac{43}{48}$

$$P_0 = \frac{1}{\underbrace{\left[\sum_{n=0}^{2} \frac{(\rho \cdot k)^n}{n!}\right]}_{(*)} + \underbrace{\frac{(\rho k)^{k-1}}{(k-1)!\,(1-\rho)}}_{(*)(*)}} = 0.0118 = \frac{100}{8461}$$

$$(*) = 1 + \left(\frac{43}{\cancel{48}_{12}} \cdot \cancel{4}\right)^1 + \frac{\left(\frac{43}{\cancel{48}_{12}} \cdot \cancel{4}\right)^2}{2} = 11.003 \sim 11$$

$$(*)(*) = \frac{\left(\frac{43}{\cancel{48}_{12}} \cdot \cancel{4}\right)^3}{3 \cdot 2 \cdot \frac{5}{48}} = 73.617$$

$$L_q = \frac{\left(\frac{43}{48}\right)^5 \cdot 4^3}{3 \cdot 2 \cdot \left(\frac{5}{48}\right)^2} \cdot \frac{100}{8461} = \frac{43^5 \cdot 4^3 \cdot \cancel{48^2}}{48^{3} \cdot 3 \cdot 2 \cdot 5^2} = 6.703$$

$$CT(k=4) = \underbrace{\cancel{1,71,41667}}_{\cancel{1,8}} \; \frac{43}{48} \cdot 10 + \underbrace{6,703 \cdot 20}_{134.06} + \underbrace{16 \cdot 4}_{64} = \cancel{199,8} \text{ [us/h]}$$

$\simeq 206.7$ [us/h]

Con $k=5$ $\rho_{k=5} = \frac{43}{60}$

$$P_0 = \frac{1}{\underbrace{\sum_{n=0}^{3,1,1} \frac{\left(\frac{43}{\cancel{60}_{12}} \cdot \cancel{5}\right)^n}{n!}}_{(*)} + \underbrace{\frac{\left(\frac{43}{\cancel{60}_{12}} \cdot \cancel{5}\right)^4}{4 \cdot 3 \cdot 2 \cdot \frac{17}{60}}}_{(*)(*)}} = 0.0233 = \boxed{\frac{233}{10000}}$$

$$CT(k=5) = 7.2 + \overbrace{1.024 \cdot 20}^{20} + \underbrace{16 \cdot 5}_{80} = \boxed{\cancel{101.28}}$$

107.2 [us/h]

$$(*) = 1 + \left(\frac{43}{12}\right) + \frac{\left(\frac{43}{12}\right)^2}{2} + \frac{\left(\frac{43}{12}\right)^3}{6} = 18.67$$

$(**) = 24.25$

$$L_q = \frac{\left(\frac{43}{60}\right)^6 \cdot 5^4}{4 \cdot 3 \cdot 2 \cdot \left(\frac{17}{60}\right)^2} \cdot \frac{233}{10000} = 1.024$$

$\underline{k=6}$: $\rho_6 = \frac{43}{72}$

$$CT(k=6) = \underbrace{0.41667 + 16 * 6}_{96.42} + \underbrace{L_q^* \cdot 20}$$

$$P_0 = \frac{1}{\underbrace{\left[\sum_{n=0}^{4} \frac{\left(\frac{43}{72\,12} * 6\right)^n}{n!}\right]}_{(*)} + \underbrace{\frac{\left(\frac{43}{72\,12} * 6\right)^5}{5*4*3*2 \cdot \frac{29}{72}}}_{(**)}} = 0.026$$

$$(*) = 18.67 + \frac{\left(\frac{43}{12}\right)^4}{24} = 23.54$$

$$(**) = 12.223$$

$$L_q = \frac{\left(\frac{43}{72}\right)^7 6^5}{5! * \left(\frac{29}{72}\right)^2} * 0.026 = 0.28143$$

$$CT(k=6) = 1.5 + 0.28143 * 20 + 16 * 6 = \boxed{\cancel{103.12}}$$

107.6

$\boxed{\therefore \ k=5}$

AEROPUERTO

→ 1 pista de aterrizaje → $\lambda_1 = 20 [av/h]$

$\mu_1 = 20 [av/h]$

→ $\lambda_2 = 30 [av/h]$

1 Con 1 pista: no estacionario.

Con 2 pistas: $k = 2$

$$\rho_2 = \frac{30}{40}$$

$$P_0 = \frac{1}{1 + \frac{\left(\frac{3}{4} \cdot 2\right)^1}{1 \cdot \left(\frac{1}{4}\right)}} = \boxed{\frac{1}{7}}$$

$$L_q = \frac{\left(\frac{3}{4}\right)^3 \cdot 2}{1! \cdot \left(\frac{1}{4}\right)^2} \cdot \frac{1}{7} = 1.93 \sim 2 \quad > 1$$

$\boxed{k = 3}$

$$\rho_3 = \frac{30}{60} = \frac{1}{2}$$

$$P_0 = \frac{1}{\underbrace{\sum_{n=0}^{1} \frac{\left(\frac{1}{2} \cdot 3\right)^n}{n!}}_{*} + \frac{\left(\frac{1}{2} \cdot 3\right)^2}{2 \cdot \left(\frac{1}{2}\right)}} = 0.21053 = \boxed{\frac{4}{19}}$$

$$* = 1 + \frac{3}{2} = \frac{5}{2}$$

$$L_q = \frac{\left(\frac{1}{2}\right)^4 \cdot 3^2}{2 \cdot \left(\frac{1}{2}\right)^2} \cdot \frac{4}{19} = \frac{3^2 \cdot \cancel{4} \cdot \cancel{2}}{2^{\cancel{3}} \cdot 19} = 0.236 \sim \boxed{0.24} < 1$$

∴ Con 3 pistas no + de un avión tendrá que esperar para aterrizar.

Escaneado con CamScanner

② $CT(K) = C_p * K + W_q * \lambda * C_e$

Con $C_p = 1000$ y C_e, el costo de espera.

Para que no convenga construir 4 pistas

$$CT(4) > CT(3)$$

$$4 \cdot C_p + 30 \cdot W_{q_4} \cdot C_e > 3C_p + 30 W_{q_3} C_e$$

$$C_p > \lambda C_e (W_{q_3} - W_{q_4})$$

$$\boxed{\frac{C_p}{\lambda (W_{q_3} - W_{q_4})} > C_e}$$

g.c.2.

$W_q \cdot L_q \cdot C_e$

X

$\frac{L_q^2}{\lambda} C_e$

$CT(4) > CT(4)$

$4C_p + \frac{L_{q_4}^2}{30} C_e > 3C_p + \frac{L_{q_3}^2}{30}$

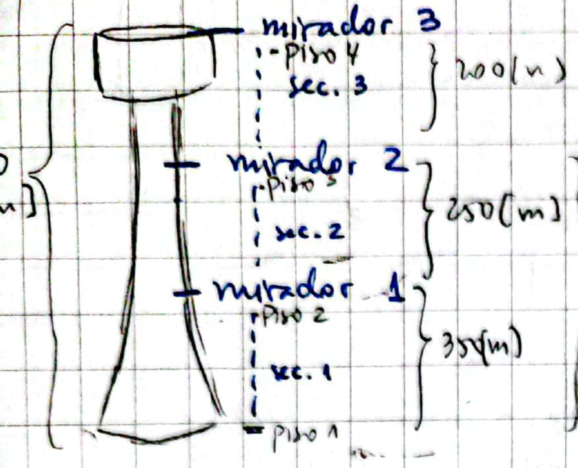
$$\boxed{\frac{30 C_p}{1 \cdot (L_{q_3}^2 - L_{q_4}^2)} > C_e}$$

③ $\lambda^* = 30 [av/h] * \frac{1 [h]}{60 [min]} = \frac{1}{2} \left[\frac{av}{m}\right]$

$$P(1 \leq t < 3) = (1 - e^{-3/2}) - (1 - e^{-1/2})$$

$$= \cancel{1} - e^{-3/2} - \cancel{1} + e^{-1/2} = \boxed{0.3834}$$

control IO:



Datos

- $\text{Capacidad}_{asc} = 15\,[p]$
- $v_{asc} = 5\,[m/s]$
- Asc van entre pisos consecutivos
- * $\lambda_{S1} = 600\,[c/h]$

$\lambda_{S2} = 0{,}7 \cdot 600 = \boxed{420\,[c/h]}$

$\lambda_{S3} = 420 \cdot 0{,}3 = \boxed{126\,[c/h]}$

$t_{sub.p} = 10\,[s]$

$t_{baj.p} = 10\,[s]$

La atención de un ascensor considera:

$\text{Piso}_1 \to \text{Piso}_2$:

$t_{1\to2} = \dfrac{350}{5} = \boxed{70\ [s]}$

$t_{total} = t_{sube\_p} + t_{baja\_p} + t_{1\to2} + t_{2\to1} = \boxed{160\,[s]}$

$\#_{\substack{veces\\ en\,[h]}} = 1\,[h] \cdot \dfrac{60\,[m]}{1\,[h]} \cdot \dfrac{60\,[s]}{1\,[m]} \cdot \dfrac{1}{160\,[s]} = 22{,}5\ [veces]$

$\mu_{1\to2} = 337{,}5\ [c/h]$

$\text{Piso}_2 \to \text{Piso}_3$:

$t_{2\to3} = \dfrac{250}{5} = 50\,[s]$

$t_{total} = 20 + 100 = 120\,[s]$

$\#_{\substack{veces\\ por\,[h]}} = \dfrac{3600\,[s]}{120\,[s]} = 30$

$\mu_{2\to3} = 450\,[c/h]$

$\text{Piso}_3 \to \text{Piso}_4$

$t_{3\to4} = \dfrac{200}{5} = 40\,[s]$ $\quad t_{total} = 20 + 80 = 100\,[s]$

$\#_{vph} = \dfrac{3600}{100} = 36 \Rightarrow \mu_{3\to4} = 540\,[c/h]$

①

En resumen:

piso	λ	μ
1-2	600	337,5
2-3	420	450
3-4	126	540.

(2) Para determinar la cantidad de ascensores, basta considerar que se cumpla el edo estacionario.

Piso 1-2:

con 1 asc: $\rho_{1-2} = \frac{600}{337{,}5} > 1$

con 2 asc: $\rho_{1-2} = \frac{600}{675} \cong 0.89 = \boxed{\frac{8}{9}}$

Piso 2-3: 1 Ascensor: $\rho_{2-3} = \frac{420}{450} = \boxed{\frac{14}{15}}$

Piso 3-4: 1 asc: $\rho_{3-4} = \boxed{\frac{7}{30}}$

∴ se necesitan 2 asc para ir al 1er entrepiso

y 1 para 2° y 3° entrepiso.

(3) $P_0 = 1 - \frac{7}{30} = \frac{23}{30}$ (prob de que hayan 0 personas en el si

En 1 hora, 46 minutos pasa desocupado.

$P_{1-2} = \frac{8}{9}$ $k = 2$

$$P_0 = \frac{1}{1 + \frac{\left(\frac{8}{9} \cdot 2\right)^1}{1 - \frac{1}{9}}} = \boxed{\frac{1}{17}}$$

$$L_q = \frac{\left(\frac{8}{9}\right)^3 \cdot 2^1}{1! \left(\frac{1}{9}\right)^2} \cdot \frac{1}{17} = \frac{8^3 \cdot 2 \cdot \cancel{9^2}}{9^3 \cdot 17} = 6.692 \sim \boxed{7}$$

∴ no hay problemas ya que solo habrían 7 personas en promedio en la cola.

5 **PISO 1**

$$W_q = \frac{L_q}{\lambda} = 0.01115 \, [h] = 40{,}152 \, [s]$$

$$t_{uso\ asc} = 70 + 10 + 10 = 90 \, [s]$$

Piso 2 :

$$W_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{420}{480(480-420)} = 0.03111 \, [h] = 112 \, [s]$$

$$t_{uso\ asc} = 10 + 10 + 50 = 70 \, (s)$$

Piso 3 : $W_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{126}{540(540-126)} = 0{,}00056 \, [h] = 2.029 \, [s]$

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad 223560$

$$t_{uso\ asc} = 10 + 10 + 40 = 60 \, (s)$$

$$T_{total} = 374{,}18\ [s] = \boxed{6.24\ [min]}$$