

Tema 2 - Teletráfico  
Soluciones de la hoja 1 de problemas

**Problema 1.**

- (a) 2000 minutos.
- (b) 11.1 Erlangs.
- (c) 11.1 llamadas.

**Problema 2.**

- (a)  $\frac{1}{3}$  llamadas.
- (b) 2 segundos.
- (c)  $\frac{2}{3}$  circuitos.
- (d)

**Problema 3.**

- (a)  $TO_A = \rho = \frac{\lambda}{\mu}$ .  
 $TO_B = \frac{\rho}{2}$ .
- (b)  $PB_A = \frac{1}{1 + \frac{2}{\rho} + \frac{2}{\rho^2}}$ .  
 $PB_B = \frac{1}{1 + \frac{2}{\rho}}$
- (c)  $\overline{T}_A = \overline{T}_B = \frac{1}{2\mu}$ .
- (d)  $\overline{T}_A = \overline{T}_B = \frac{1}{\lambda}$ .
- (e) A:  $p_1 = \frac{\rho}{1 + \rho + \frac{\rho^2}{2}}$        $p_2 = \frac{\frac{\rho^2}{2}}{1 + \rho + \frac{\rho^2}{2}}$   
B:  $p_1 = \frac{\frac{\rho}{2}}{1 + \frac{\rho}{2}}$ .
- (f) A:  $p_0 = \frac{1}{1 + \rho + \frac{\rho^2}{2}}$   
B:  $p_0 = \frac{1}{1 + \frac{\rho}{2}}$ .
- (g)  $\overline{N}_A = \frac{\rho + \rho^2}{1 + \rho + \frac{\rho^2}{2}}$   
B:  $\overline{N}_B = \frac{\frac{\rho}{2}}{1 + \frac{\rho}{2}}$ .
- (h) A:  $\lambda_C = \lambda(1 - PB_A)$ .  
B:  $\lambda_C = \lambda(1 - PB_B)$ .

**Problema 4.**

- (a)  $TO_a = 10$  Erlangs.  
 $TO_b = 20$  Erlangs.
- (b)  $PB_a = PB_b \approx 0.245$ .
- (c)  $TC_a \approx 7.55$  Erlangs.  
 $TC_b \approx 15.1$  Erlangs.
- (d)  $TP_a \approx 2.45$  Erlangs.  
 $TP_b \approx 4.9$  Erlangs.
- (e)  $Pr_a = \frac{1}{3}$   
 $Pr_b = \frac{2}{3}$ .
- (f)  $Pr_a = \frac{1}{3}$   
 $Pr_b = \frac{2}{3}$ .

**Problema 5.**

- (a)  $TC \approx 7.85$  Erlangs.
- (b)  $TC \approx 0.586$  Erlangs.
- (c)  $\lambda_C \approx 27.3$  llamadas/hora.
- (d)  $\lambda_C \approx 17.6$  llamadas/hora.
- (e)  $TC \approx 7.85$  Erlangs.
- (f)  $TC \approx 0.785$  Erlangs.
- (g)  $TC \approx 0.785$  Erlangs.
- (h)  $\lambda_C \approx 23.6$  llamadas/hora.

**Problema 6.**

- (a) 0.4
- (b) 0.4
- (c)  $\overline{N} = 1.2$  circuitos.
- (d) 0.667
- (e) 0.2
- (f) 0.4
- (g)  $\overline{N} = 1.2$  circuitos.

**Problema 7.**

- (a) 2
- (b) 3
- (c) 2
- (d) 4

**Problema 8.**

- (a)  
 (b)  $p_{00} \approx 0.571$   $p_{10} \approx 0.286$   
 $p_{01} \approx 0.057$   $p_{11} \approx 0.086$   
 (c)  $TO \approx 0.55$  Erlangs.  
 (d)  $\bar{N} = 0.514$  líneas.  
 (e)  $PB \approx 0.086$ .

**Problema 9.**

- (a)  $TC \approx 1.96$  Erlangs.  
 (b)  $TC \approx 1.04$  Erlangs.  
 (c) 0.39.  
 (d) 0.865.  
 (e) 4.2 Erlangs.

**Problema 10.**

- (a) 0.28 segundos.  
 (b) 0.23 segundos.

**Problema 11.**

- (a) 2)  
 (b) 2)  
 (c) 3)  
 (d) 3)

**Problema 12.**

- (a)  
 (b)  $p_i = \frac{A}{i!} \left(\frac{A}{2}\right)^{i-1} p_0$   $i > 0$   
 $p_0 = \frac{1}{2e^{\frac{A}{2}} - 1}$ .  
 (c)  $\bar{\lambda} = p_0 \lambda \left[ \frac{4}{A} \left( e^{\frac{A}{2}} - 1 \right) - 1 \right]$ .  
 (d)  $\bar{N} = p_0 A e^{\frac{A}{2}}$ .  
 (e)  $\bar{N}_{\text{cola}} = A p_0 \left( e^{\frac{A}{2}} + 1 \right) - 4 p_0 \left( e^{\frac{A}{2}} - 1 \right)$   
 $\bar{N}_{\text{servidor}} = p_0 \left( 4e^{\frac{A}{2}} - 4 - A \right)$ .  
 (f)  $\bar{W}_{\text{cola}} = \frac{1}{\mu} \left[ \frac{A e^{\frac{A}{2}}}{4e^{\frac{A}{2}} - 4 - A} - 1 \right]$ .  
 $\bar{W}_{\text{servidor}} = \frac{1}{\mu}$ .

**Problema 13.**

- (a)  
 (b)  $p_i = A^i p_0$   $i \leq N$   
 $p_i = 2^N \left(\frac{A}{2}\right)^i p_0$   $i > N$   
 $p_0 = \frac{1}{\frac{1-A^{N+1}}{1-A} + \frac{A^{N+1}}{2-A}}$ .  
 (c)  $TO = A$   
 (d)  $TC = A p_0 \frac{1-A^N}{1-A}$ .  
 (e)  $PB = 1 - p_0$ .  
 (f)  $p_0 \frac{A^{N+1}}{2-A}$ .

**Problema 14.**

- (a)  
 (b)  $p_0 = 0.482$   $p_1 = 0.386$   $p_2 = 0.116$   
 $p_3 = 0.015$   $p_4 = 0.01$ .  
 (c)  $\bar{N} = 0.667$   
 (d) 0.1 segundos.

**Problema 15.**

- (a)  
 (b)  $p_0 = p_1 = p_2 = \frac{4}{15}$   $p_3 = \frac{2}{15}$   $p_4 = \frac{1}{15}$ .  
 (c)  $p_{C \text{ bps}} = \frac{8}{15}$   $p_{2C \text{ bps}} = \frac{1}{5}$   
 (d)  $PB = \frac{1}{15}$   
 (e)  $\bar{W} = \frac{11}{7}$  segundos.

**Problema 16.**

- (a)  $u = 320$  paquetes/segundo.  
 (b)  $\lambda_1 = \frac{1600}{3}$  pkt/s  $\lambda_2 = \frac{320}{3}$  pkt/s.

**Problema 17.**

- (a)  $TO_A = TC_A = 2$  Erlangs  
 $TO_B = TC_B = 0.9$  Erlangs.  
 (b)  $\bar{W}_A \approx 26$  segundos  
 $\bar{W}_B = 81$  minutos.  
 (c) 48 llamadas

**Problema 18.**

- (a)  $PB_1 \approx 0.21$   $PB_2 = 0.2$ .  
 (b) 0.4.  
 (c)  $\bar{N}_1 = \frac{30}{19}$   $\bar{N}_2 = 0.8$   
 $\bar{W}_1 = 1$  s  $\bar{W}_2 = 0.5$  s

**Problema 19.**

- (a) Original:  $p_i = \left(\frac{\lambda L}{C}\right)^i \frac{1}{2^{i-1}} \frac{2C-\lambda L}{2C+\lambda L} \quad i > 0$   
 $p_0 = \frac{2C-\lambda L}{2C+\lambda L}$   
 Alternativo:  $p_i = \left(\frac{\lambda L}{C\alpha}\right)^i \frac{C\alpha-\lambda L}{C\alpha}$
- (b) Original:  $\overline{W}_{cola} = \frac{L(\lambda L)^2}{C[(2C)^2-(\lambda L)^2]}$   
 Alternativo:  $\overline{W}_{cola} = \frac{\lambda L^2}{C\alpha(C\alpha-\lambda L)}$
- (c)  $\alpha = 1 + \frac{\lambda L}{C} \left[1 - \frac{\lambda L}{4C}\right]$
- (d) Sí

**Problema 20.**

- (a)  $\frac{2}{5}$   
 (b)  $\overline{N} = \frac{4}{5} \quad \overline{W} = \frac{1}{2}$   
 (c)  $\frac{1}{5}$   
 (d)  $\frac{17}{57}$   
 (e)  $PB_1 = \frac{17}{57} \quad PB_2 = \frac{25}{57}$

**Problema 21.**

- (a)  $p_i = p_0 A^i \quad i < S$   
 $p_i = p_0 A^i q^{i-S} \quad i \geq S$   
 $p_0 = \frac{1}{\frac{1-A^{S+1}}{1-A} + \frac{A^{S+1}q}{1-Aq}}$
- (b)  $q < \frac{C}{\lambda L}$
- (c)  $(1-q) \frac{1}{\frac{1-A^S}{1-A} + \frac{A^S}{1-Aq}} \frac{A^S}{1-Aq}$
- (d)  $p_0 \left[ \frac{A^2(1-A^S)}{(1-A)^2} - \frac{SA^{S+1}}{1-A} + \frac{A^{S+2}q^2}{(1-Aq)^2} + \frac{A^{S+1}Sq}{1-Aq} \right]$
- (e)  $\frac{1}{\lambda} \frac{\frac{A^2(1-A^{S-1})}{(1-A^2)} - \frac{(S-1)A^S}{1-A} + \frac{A^S Aq}{(1-Aq)^2} + \frac{A^S(S-1)}{1-Aq}}{\frac{1-A^S}{1-A} + A^S \frac{q}{1-Aq}}$
- (f)  $\frac{A}{\mu-\lambda}$

**Problema 22.**

- (a)  $PB \approx 0.21 \quad TC \approx 1.58$
- (b)  $\overline{W} = 1$  minuto  
 Porcentaje ocupación: 52.63 %
- (c) 4 operadores.
- (d)  $\approx 0.21$
- (e) 41.7 %
- (f)  $PB_{\text{premium}} \approx 0.094$   
 $PB_{\text{no-premium}} \approx 0.458$
- (g)  $TC \approx 1.37$  Erlangs  
 $\overline{W} = 1$  minuto.
- (h)  $\approx 3$  horas y 36 minutos.

**Problema 23.**

- (a)  $p_i = 2 \left(\frac{A}{2}\right)^i \quad i > 0$   
 $p_0 = \frac{1-\frac{A}{2}}{1+\frac{A}{2}}$
- (b)  $\overline{N} = \frac{A}{1-\frac{A^2}{4}} \quad \overline{W} = \frac{1}{\mu} \frac{1}{1-\frac{A^2}{4}}$
- (c)  $p_i = A^i (1-A)$   
 $\overline{N} = \frac{A}{1-A} \quad \overline{W} = \frac{1}{\mu} \frac{1}{1-A}$
- (d)  $p_{10} = p_0 \frac{A}{2} \quad p_{01} = p_0 \frac{A}{2\alpha}$   
 $p_i = p_0 \frac{A^i}{(1+\alpha)^{i-2}} \frac{1}{2\alpha}$   
 $p_0 = \frac{2\alpha(1+\alpha-A)}{2\alpha(1+\alpha)+A(1+\alpha^2)}$
- (e)  $A = (1+\alpha) \left(1 - \sqrt{\frac{\alpha(1+\alpha)}{1+\alpha^2}}\right)$

**Problema 24.**

- (a) 0.4
- (b)  $\overline{W}_{\text{espera}} = \frac{1}{2}$  minutos  
 $\overline{W}_{\text{total}} = \frac{3}{2}$  minutos.
- (c)  $\approx 0.46$
- (d)  $\overline{W}_{\text{espera}} = 0$  minutos  
 $\overline{W}_{\text{total}} = \frac{5}{8}$  minutos.

**Problema 25.**

- (a)  $Pr_{\text{espera}} = \frac{1}{3} \quad PB = \frac{1}{3}$
- (b)  $\overline{W}_{\text{espera}} = 10$  minutos  
 $\overline{W}_{\text{total}} = 30$  minutos.
- (c)  $Pr_{\text{espera}} = 0.6 \quad PB = 0.4$
- (d)  $\overline{W}_{\text{espera}} = 20$  minutos  
 $\overline{W}_{\text{total}} = 40$  minutos.

**Problema 26.**

- (a)  $Pr_{\text{pérdida}} = \frac{1}{5}$
- (b)  $\overline{N} = 0.8$   
 $\overline{W}_{\text{aplicación}} = 3$  segundos.
- (c)  $(Pr_{\text{pérdida}})_{\text{RRHH}} = \frac{1}{5}$   
 $(Pr_{\text{pérdida}})_{\text{No RRHH}} = \frac{1}{5}$
- (d)  $(Pr_{\text{pérdida}})_{\text{RRHH}} = \frac{1}{16}$   
 $(Pr_{\text{pérdida}})_{\text{No RRHH}} = \frac{1}{4}$
- (e)  $\overline{N}_{\text{procesos}} = \frac{7}{8}$   
 $\overline{N}_{\text{espera}} = \frac{1}{16}$
- (f)  $\overline{W}_{\text{espera}} = \frac{3}{14}$  segundos ( $\approx 0.214$  s)  
 $\overline{N}_{\text{espera}} = \frac{45}{14}$  segundos ( $\approx 3.214$  s)
- (g)  $Pr_{\text{pérdida}} = \frac{1}{8}$

**Problema 27.**

- (a)  $Pr_{\text{bloqueo}} = \frac{2}{7}$   
 $\overline{W}_{\text{espera}} = \frac{1}{5} \text{ min (12 s)}$ .
- (b)  $Pr_{\text{bloqueo}} = \frac{3}{13}$   
 $\overline{W}_{\text{espera}} = \frac{1}{6} \text{ min (10 s)}$ .
- (c)  $Pr_{\text{bloqueo}} = \frac{1}{6}$   
 $\overline{W}_{\text{espera}} = \frac{1}{10} \text{ min (6 s)}$ .
- (d)  $\alpha = \frac{1}{2}$   
 $\overline{W}_{\text{espera}} = \frac{1}{8} \text{ min (7.5 s)}$ .

**Problema 28.**

- (a)  $Pr_{\text{bloqueo}} = \frac{1}{3}$ .
- (b)  $\overline{W}_{\text{espera}} = 5 \text{ min}$ .  
 $\overline{W}_{\text{total}} = 15 \text{ min}$ .
- (c)  $Pr_{\text{bloqueo}} = \frac{4}{7}$ .
- (d)  $\overline{W}_{\text{simulación}} = 20 \text{ min}$ .  
 $\overline{W}_{\text{espera}} = \frac{40}{3} \text{ min (800 s)}$ .
- (e)  $\overline{\text{Simulaciones}} = 2$ .  
 $\overline{W}_{\text{simulación}} = 10 \text{ min}$ .