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S20190010098

1.

a, Throughput $= \min(R_1, R_2, R_3) = 500\,kbps$

b, Time $= 64\,sec$

$\quad$ File size $= 64 \times 500 \times 10^3$

$\quad\quad\quad = 320 \times 10^5\,bits$

$\quad\quad\quad = \dfrac{320 \times 10^5}{8}\,bytes$

$\quad\quad\quad = 4 \times 10^6\,bytes$

$\quad$ File size $= 4\,MB$

2.

$\quad$ File size $= 147500\,bytes$

$\quad$ bit rate $= \dfrac{2.6\,MPbs}{13} = 0.2\,Mbps$

Transmission delay $= 15\,ms + \dfrac{147500 \times 8}{0.2 \times 10^6}\,sec$

$\quad\quad = 15\,ms + \dfrac{1.475 \times 84}{2}\,sec$

$\quad\quad = 15\,ms + 5.900\,sec$

$\quad\quad = \boxed{5.915\,sec}$

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3.

Propagation time $= \dfrac{3400 \times 1000}{2.5 \times 10^8}$

$= \dfrac{34}{2500} = 1.36 \times 10^{-2}$

$= 13.6\,ms$

(∵ 10Mbps → Transmission rate.)

6.

$\mu_1 \sin\phi_1 = \mu_2 \sin\phi_2$

$1.7 \sin\phi_1 = 1.2 \times \sin(90°)$

$\sin\phi_1 = \dfrac{12}{17}$

$= 0.70586$

$\phi_1 = 44.9$.

7. Minimum bandwith = signals in hertz *
number of signals + guard bond *
avoiding interference.

a) $= 4000 * 10 + 0 = 40000\,Hz = 40\,KHz$

b) $= 4000 * 10 + 400 * 9 = 43600 = 43.6\,KHZ$.