City University of Hong Kong
Department of Electronic Engineering

EE3009 Data Communications & Networking

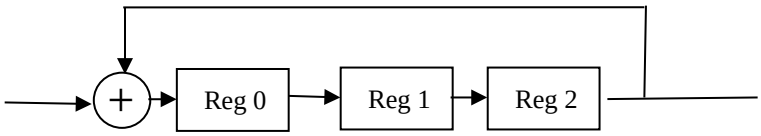
Solution to Test 2

1.
   a. 44 kHz
   b. $44x10^3 x16 = 704$ kb/s

2. Nyquist pulses can be sent over this channel at a rate of 20000 pulses per second. Each pulse carries $\log_2 32 = 5$ bits of information, so the bit rate is 100000 bits per second.

3. a. 01011001
   b. $\binom{8}{2} p^2 (1-P)^6$

4. a.



b
```
          10110111
      ------------
1001 | 10100001000
       1001
       ----
        1100
        1001
        ----
         1010
         1001
         ----
          1110
          1001
          ----
           1110
           1001
           ----
            1110
            1001
            ----
             111  ← Remainder
```

Code word is 10100001111

5. In CHAP, the password is encrypted, and the authenticator can reissue challenge during the session.

6. First, we have the following:

$$n_f = 512 \times 8 = 4096$$

$$P_f = 1 - (1 - 10^{-4})^{4096} = 0.3361$$

$$\eta = (1 - \frac{n_0}{n_f})(1 - p_f) = (1 - \frac{32}{4096})(1 - 0.3361) = 0.6587$$

7. $$X = \frac{12500 \times 8}{10 \times 10^6} = 10^{-2} s$$

$$\tau' = M(\frac{2d}{v} + \frac{b}{R}) = 25(\frac{5000}{2.5 \times 10^8} + \frac{8}{10 \times 10^6}) = 5.2 \times 10^{-4} s$$

$$\rho_{\max} = \frac{1}{1 + a'(1 + \frac{1}{M})} = \frac{1}{1 + \frac{5.2 \times 10^{-4}}{10^{-2}}(1 + \frac{1}{25})} = 94.87\%$$

8. $S = Ge^{-G}$

$\frac{dS}{dG} = -Ge^{-G} + e^{-G} = 0$

$e^{-2G}(1 - G) = 0$

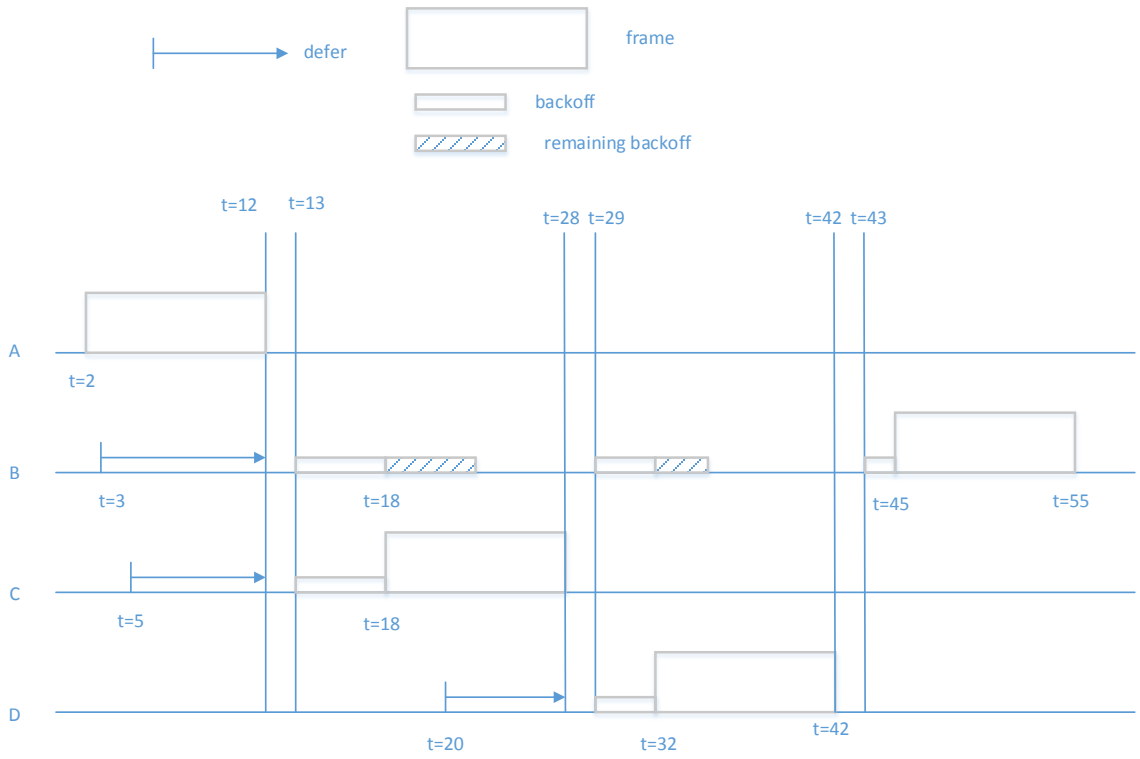
When G=1, S is maximized.

Maximum $S = (e)^{-1}$=36.8%

9. The vulnerable period of slotted Aloha is half of that of Aloha (or, the maximum throughput of slotted Aloha is twice of Aloha). This is achieved by restricting stations to transmit frames only at the beginning of a slot.

10. DLE, STX, DLE, DLE, STX, A, A, DLE, DLE, B, B, DLE, DLE, ETX, DLE, ETX

11.


defer
frame
backoff
remaining backoff
t=12
t=13
t=28
t=29
t=42
t=43
A
t=2
B
t=3
t=18
t=45
t=55
C
t=5
t=18
D
t=20
t=32
t=42