Solution 1: (a) An ISBN-10 code is a 10 digit number of the form \((a_1a_2 \ldots a_{10})\), where \(a_{10}\) is the check digit calculated as

\[
a_{10} = (a_1 + 2a_2 + 3a_3 + \cdots + 9a_9) \mod 11 = 0
\]

Solution 2: (c) A Bookland Bar code (ISBN-13) is a 13 digit number of the form \((a_1a_2 \ldots a_{13})\), such that

\[
a_1 + 3a_2 + a_3 + 3a_4 + \cdots + a_{11} + 3a_{12} + a_{13} = 0 \mod 10
\]

Only option (c) satisfies the above equation.

Solution 3: (d) An European Article number (EAN) is a 13 digit number of the form \((a_1a_2 \ldots a_{13})\), where \(a_{13}\) is the check digit calculated using

\[
(a_1 + 3a_2 + a_3 + 3a_4 + a_5 + \cdots + a_{11} + 3a_{12} + a_{13}) \mod 10 = 0
\]

Solution 4: (b) In the CRC code for \((10,6)\) code with generator polynomial \(g(x) = x^4 + x + 1\) and input sequence \((a_5, a_4, \ldots, a_0)\), the parity bits \(c_3, c_2, c_1, c_0\) are calculated such that the polynomial

\[
C(x) = a_5x^9 + a_4x^8 + a_3x^7 + a_2x^6 + a_1x^5 + a_0x^4 + c_3x^3 + c_2x^2 + c_1x + c_0
\]

is divisible by \(g(x)\). Here, information sequence is 1 1 0 0 1 0, therefore

\[
C(x) = x^9 + x^8 + x^5 + c_3x^3 + c_2x^2 + c_1x + c_0
\]

Only 1 0 0 1 satisfies this condition, therefore correct option is (b).

Solution 5: (c) In a Go-Back-N ARQ protocol where transmitter uses \((n, k) = (16, 12)\) code, with window length \(N = 10\) and probability of acceptance of frame \(P = 0.01\), the efficiency is given as

\[
\eta = \left(\frac{k}{n}\right) \left(\frac{P}{P + N \cdot (1 - P)}\right) \approx 7.6 \times 10^{-4}
\]

Solution 6: (b) Reliability is measured by frame error rate which depends on the error detecting code used and is independent of the ARQ protocol.

Solution 7: (d) All the statements are correct (Please see the slides), hence the correct option is (d)

Solution 8: (c) The average CWEF of the PCBC with two systematic \((n, k)\) constituent codes \(C_1\) and \(C_2\) with CWEFs \(A_w^{C_1}(Z)\) and \(A_w^{C_2}(Z)\) separated by a uniform interleaves of size \(N = k\) is given by.

\[
A_w^{PC}(Z) = \frac{A_w^{C_1}(Z)A_w^{C_2}(Z)}{\binom{N}{w}}
\]

In a \((6,5)\) SPC, the IRWEF is given as

\[1 + 5WZ + 10W^2 + 10W^3Z + 5W^4 + W^5Z\]
So, there are 10 codewords of input weight 3 and parity weight 1. Therefore, the average CWEF for input weight 3 is given by

\[ A^\text{PC}_3(Z) = \frac{(10Z)^2}{5 \binom{3}{1}} = 10Z^2 \]

**Solution 9: (b)** The average IRWEF is given as

\[ A^\text{PC}_W(W, Z) = \sum_{1 \leq w \leq N} W^w A^\text{PC}_w(Z) \]

In Q-8, we can calculate the average CWEFs as

\[
\begin{align*}
A^\text{PC}_1(Z) &= \frac{5Z^2}{5 \binom{3}{1}} = 5Z^2, \\
A^\text{PC}_4(Z) &= \frac{5^2}{5 \binom{4}{4}} = 5 \\
A^\text{PC}_2(Z) &= \frac{10Z}{5 \binom{2}{2}} = 10, \\
A^\text{PC}_5(Z) &= \frac{Z^2}{5 \binom{5}{5}} = Z^2 \\
A^\text{PC}_3(Z) &= \frac{(10Z)^2}{5 \binom{3}{2}} = 10Z^2,
\end{align*}
\]

Therefore, the average IRWEF is given as

\[ A^\text{PC}_W(W, Z) = 5WZ^2 + 10W^2 + 10W^3Z^2 + 5W^4 + W^5Z^2 \]

**Solution 10: (a)** The average WEF is given as

\[ A^\text{PC}_w(X) = A^\text{PC}_w(W, Z)|_{W=Z=X} = 10X^2 + 5X^3 + 5X^4 + 10X^5 + X^7 \]