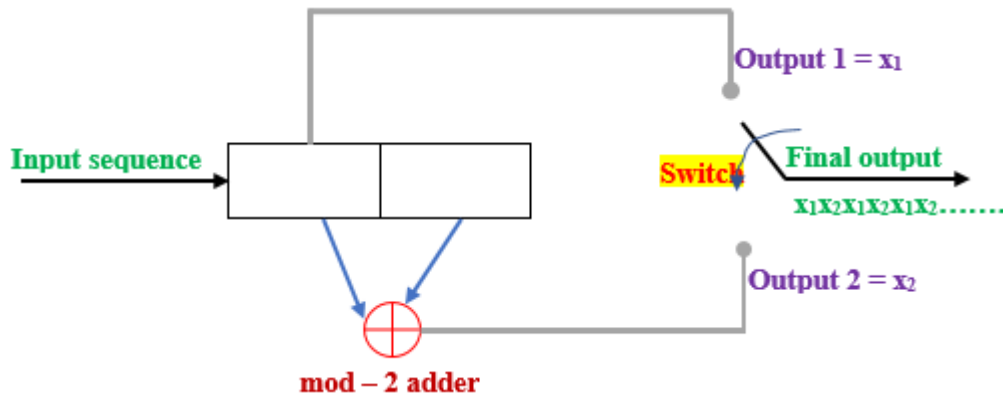# Homework Questions - Convolutional codes

Q1. Below figure depicts a rate ½, constraint length K = 2, convolutional encoder. Sketch the tree diagram, the trellis diagram and the state diagram.

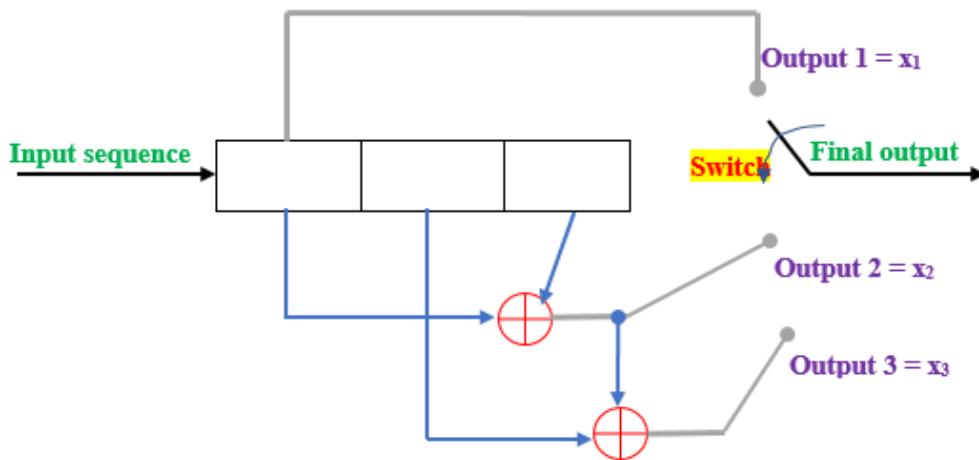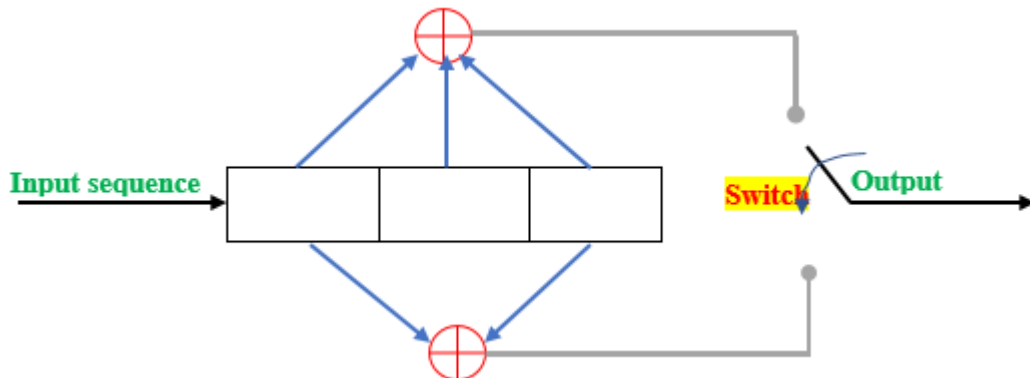**Q2**. The convolutional encoder has the following generator sequences each of length 3.

$$\left(g_0^{(1)}, g_1^{(1)}, g_2^{(1)}\right) = (1,1,1) \qquad\qquad \left(g_0^{(2)}, g_1^{(2)}, g_2^{(2)}\right) = (1,0,1)$$

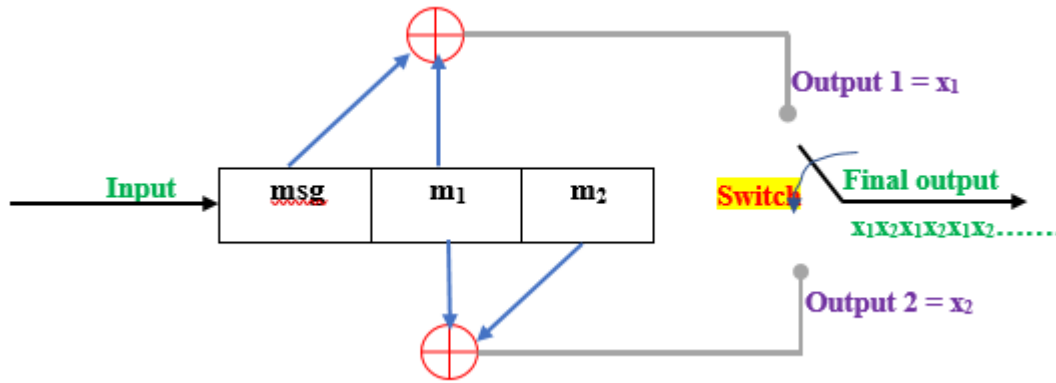Determine the encoded sequence for the following input message m = 100101

Q3. The block diagram of a binary convolutional encoder is shown below. Draw the state diagram for the Code.

Q4. A rate ½, L = 3 binary convolutional encoder is shown in below figure. Draw the Tree, Trellis and State Diagrams.

Q5. Draw the State diagram for the convolutional code generated by the encoder shown below.

Q6. Determine the state and trellis diagram for a convolutional encoder with L = 2, code rate R = 1/3 and generator sequences given by the following polynomials:
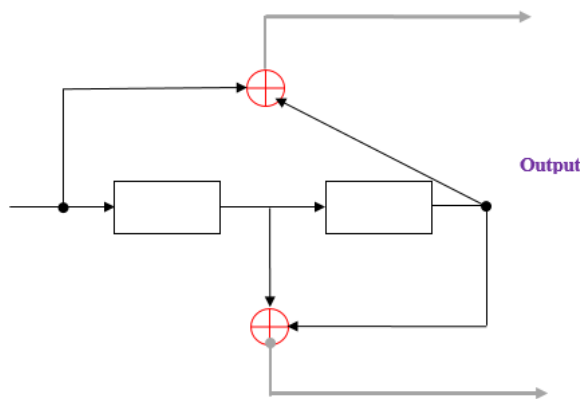
$$g^{(1)}(D) = D + D^2 \qquad g^{(2)}(D) = 1 + D \qquad g^{(3)}(D) = 1 + D + D^2$$

Q7. A binary convolutional error correcting code has k = 1, n = 3, K (constraint length) = 2 and
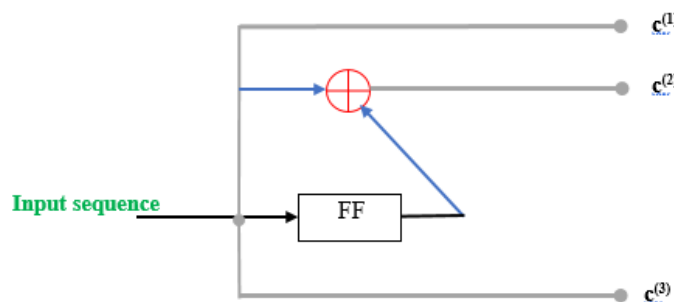
$$g^{(1)}(D) = 1 + D^2 \qquad g^{(2)}(D) = D \qquad g^{(3)}(D) = D + D^2$$

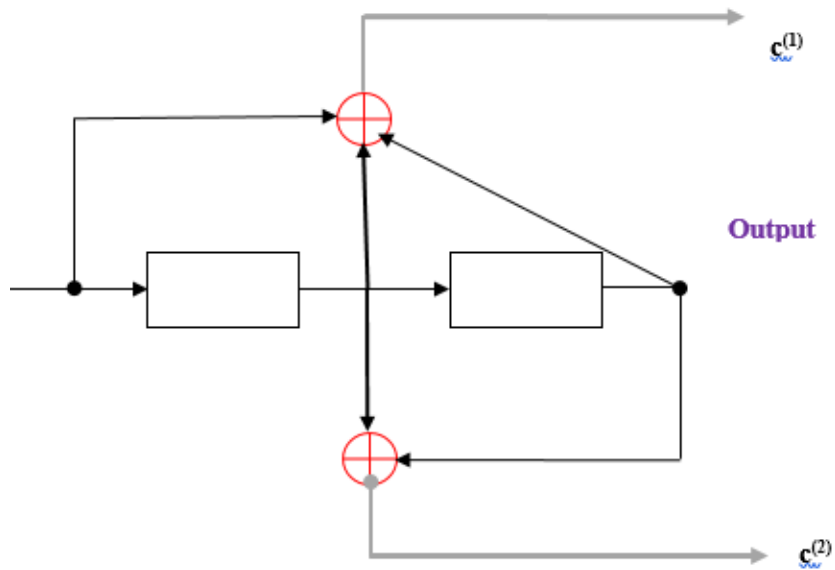Draw the encoder circuit and its Trellis diagram

Q8. For the convolutional encoder shown in below figure,
   a.   Determine the generator polynomials of the encoder
   b.   Determine the coded output for the input message m = (101)

Q9. Draw the trellis diagram of the binary convolutional encoder given in below figure for which code rate R = 1/3

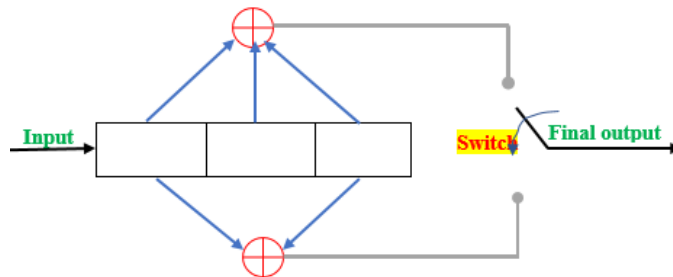**Q10**. Draw the trellis diagram of the binary convolutional code generated by the below encoder

Q11. Consider the (3, 1, 2) convolutional encoder with

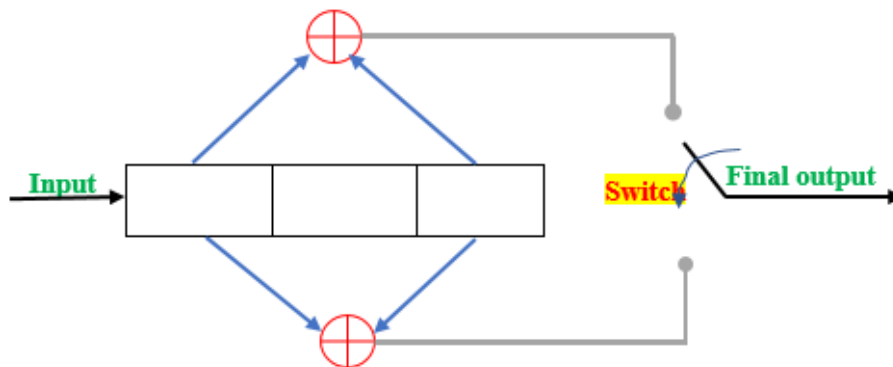$$g^{(1)} = (110) \qquad g^{(2)} = (101) \qquad g^{(3)} = (111)$$

    a. Draw the encoder block diagram.
    b. Find the codeword corresponding to the information sequence m = 11101

Q12. Draw the state diagram, tree diagram and trellis diagram for the convolutional encoder characterised by the block diagram in below figure:
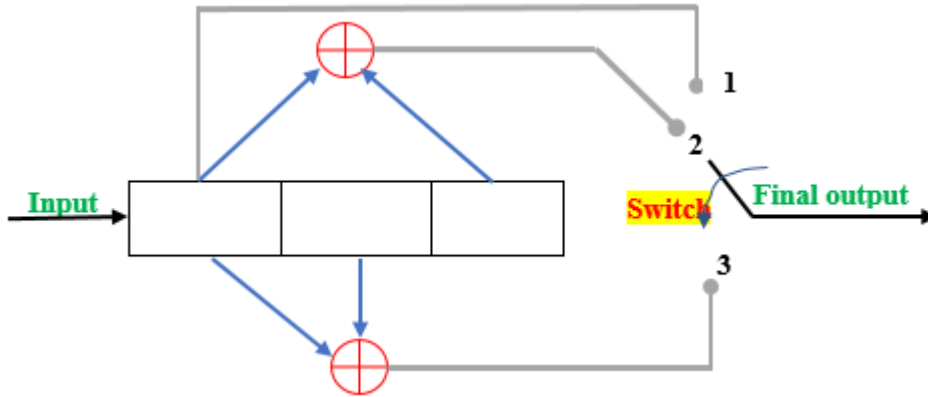

Q13. Consider the convolutional encoder shown in below figure:
    a) Write connection vectors & polynomials for this encoder
    b) Draw the state diagram, tree diagram and trellis diagram

Q14. For the convolutional encoder shown below, determine the output digit sequence for the data digits 110101100
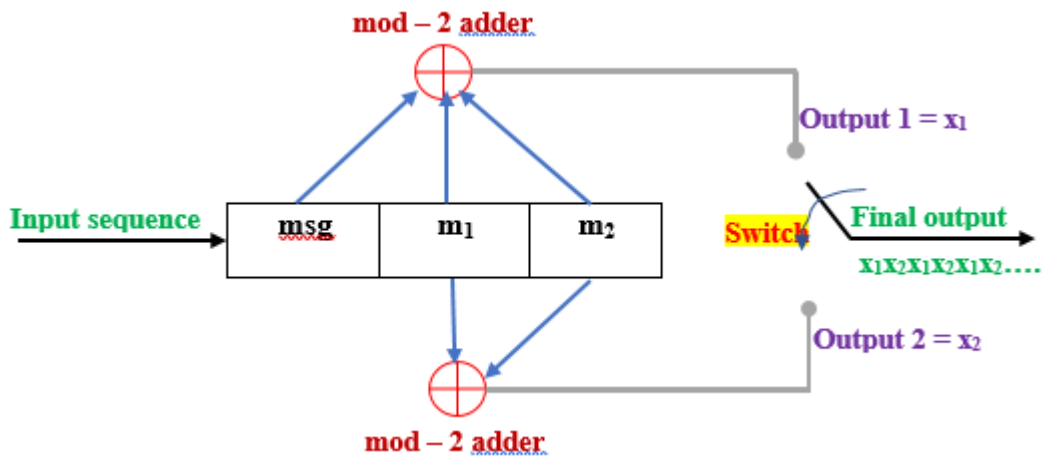

Q15. Draw the state diagram, tree diagram and trellis diagram for the L = 3, rate 1/3 code generated by:
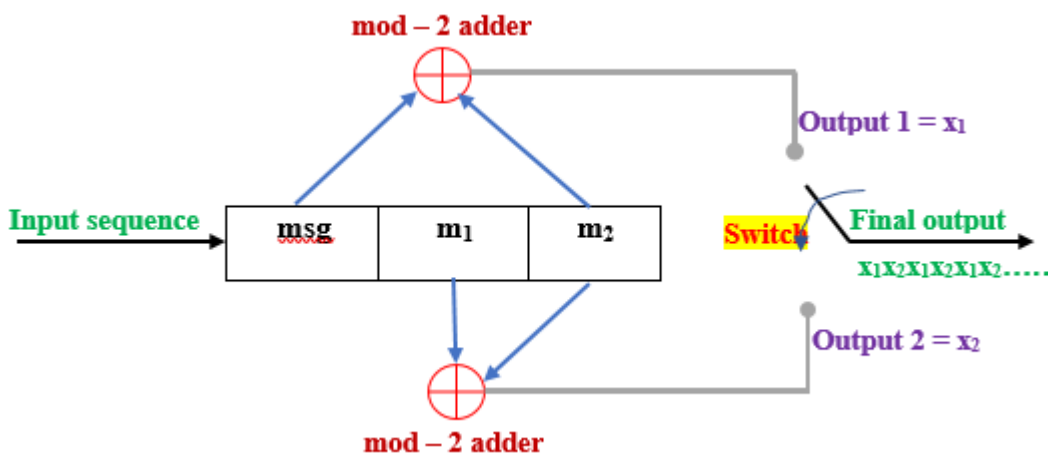
$$g_1(X) = X + X^2$$
$$g_2(X) = 1 + X$$
$$g_3(X) = 1 + X + X^2$$

Q16. Draw the state diagram, tree diagram and trellis diagram for the convolutional encoder characterised by the below block diagram.
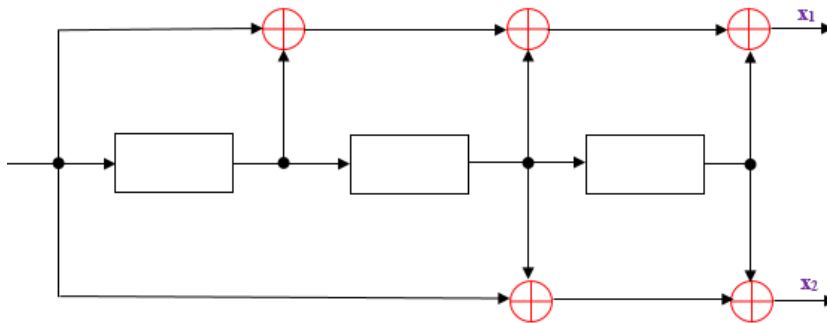

Q17. Consider the convolutional encoder shown in below figure:

a) write the connection vectors and polynomials for this encoder
b) Draw the state diagram, tree diagrams and trellis diagrams

Q18. What is the impulse response of the encoder above problem? Using the impulse response, determine the output sequence when the input is 101. Verify by using the generator polynomials.
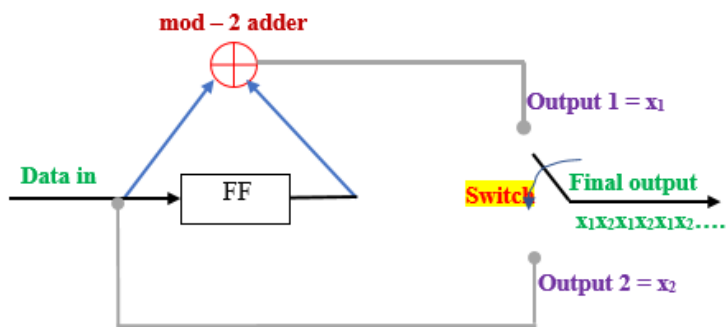
Q19. Consider the rate r = ½ convolutional encoder illustrated in fig below. Find the generator polynomial G(D).
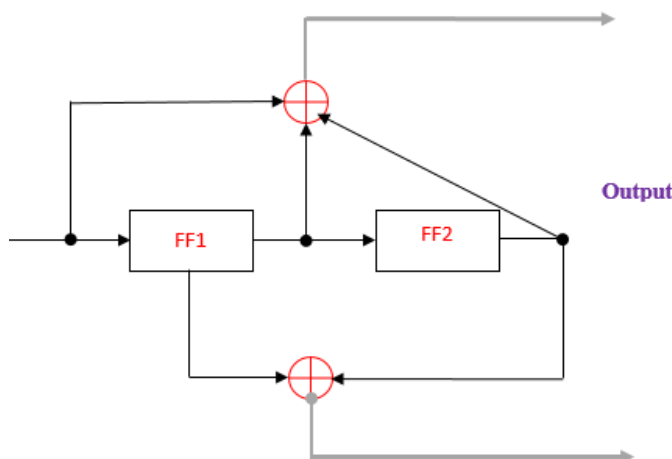

Q20. $g^{(1)} = (1, 1, 1)$
$g^{(2)} = (1, 0, 1)$
Let message sequence = 10011. Find the convolutional codes for given message input.

Q21. A convolutional encoder has a single shift register with two stages (i.e., constraint length K = 3), three mod-2 adders and an output multiplexer. The generator sequences of the encoder as follows:
$g^{(1)} = (1, 0, 1)$ $g^{(2)} = (1, 1, 0)$ $g^{(3)} = (1, 1, 1)$
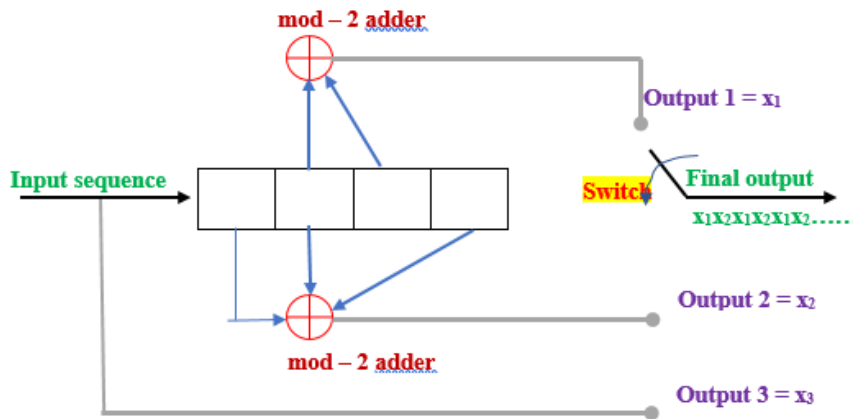Draw the block diagram of the encoder.

Q22. Consider the rate r = ½, constraint length K = 2 convolutional encoder below. The code is systematic. Find the encoder output produced by the message sequence 10111……….
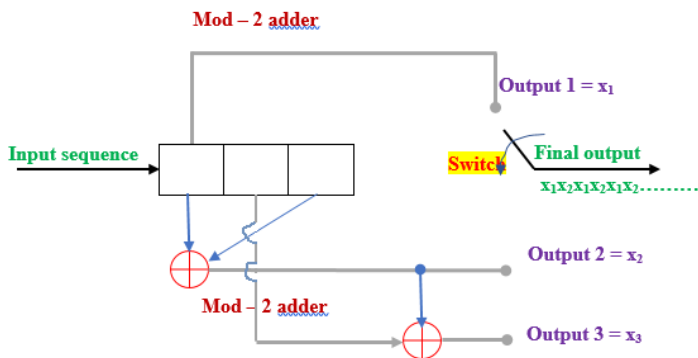

Q23. The (2, 1, 2) convolutional encoder can be expressed as 2 generator polynomials with $G_1(D) = 1 + D + D^2$ and $G_2(D) = 1 + D^2$. Let the message sequence = 110111001000. Find output.

Q24. Determine the output from the encoder of figure below for message i/p of M = (1101011110000……..)

Q25. The block diagram of a binary convolutional encoder is shown below:

   a) Find the state diagram for the code
   b) Find trellis diagram

Q26. A convolutional code is described by

   $g_1 = [1\ 0\ 0]$ $g_2 = [1\ 0\ 1]$ $g_3 = [1\ 1\ 1]$
   a) Draw the encoder corresponding to this code
   b) Draw the state transition diagram for this code

Q27. Repeat above question for

   $g_1 = [1\ 1\ 0]$ $g_2 = [1\ 0\ 1]$ $g_3 = [1\ 1\ 1]$

Q28. Below figure shows the encoder for a rate ½, K = 4 convolutional encoder. Determine the encoder output produced by the message sequence 10111