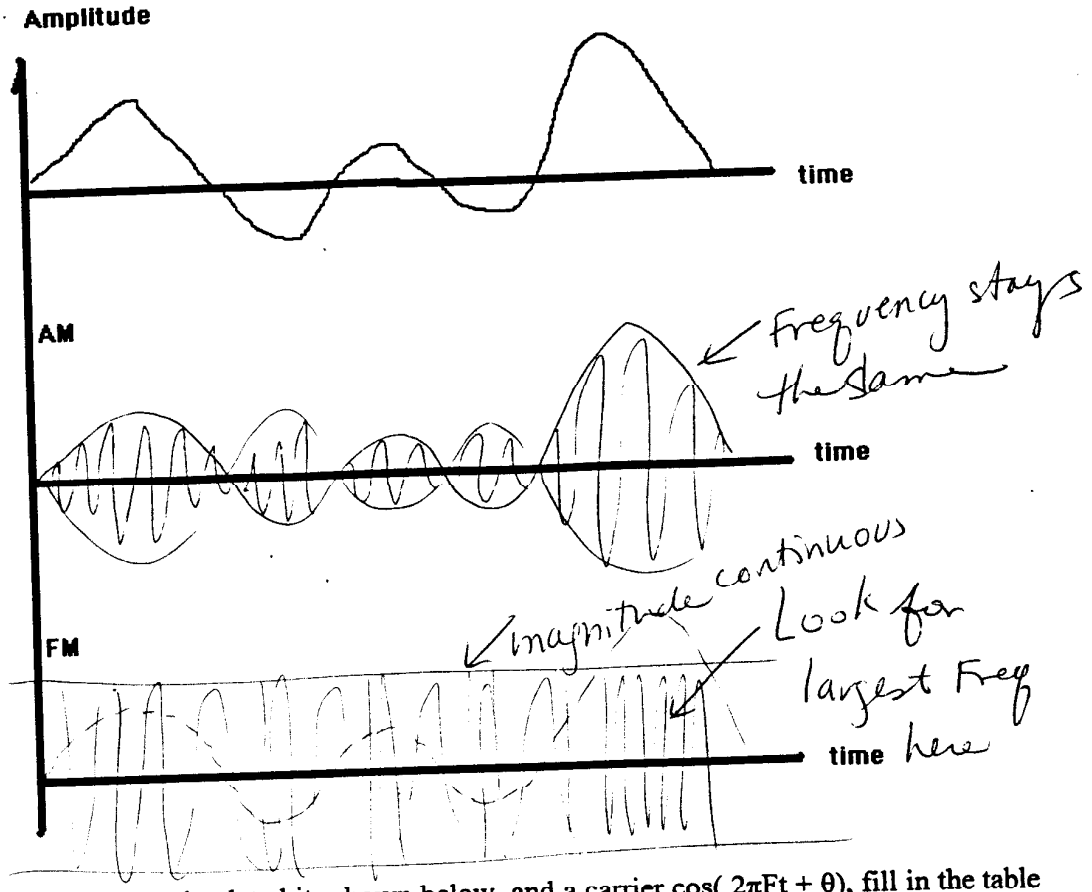
1. (20 points)

(a) For the signal shown below, sketch the AM and FM transmitted signals



(b) For the data bits shown below, and a carrier $\cos(2\pi Ft + \theta)$, fill in the table to show what the phase $\underline{\theta}$ of the carrier will be.

BPSK	θ
0	0°
1	180°

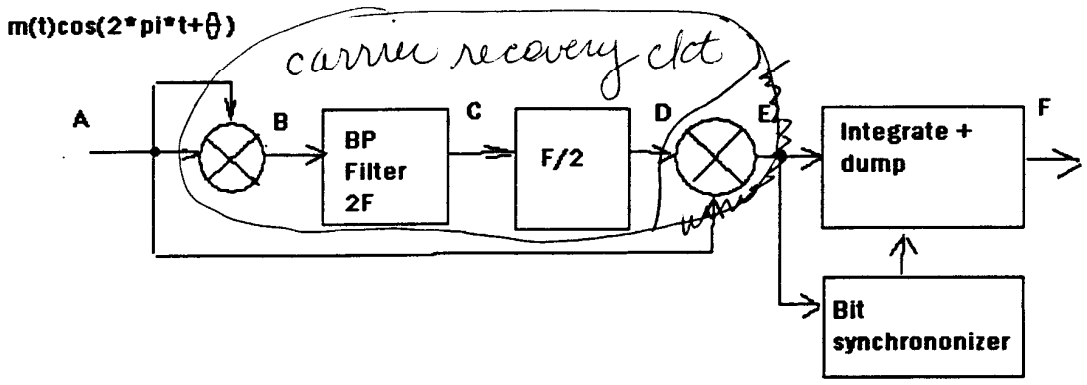
QPSK	θ
00	0°
01	90°
10	180°
11	270°

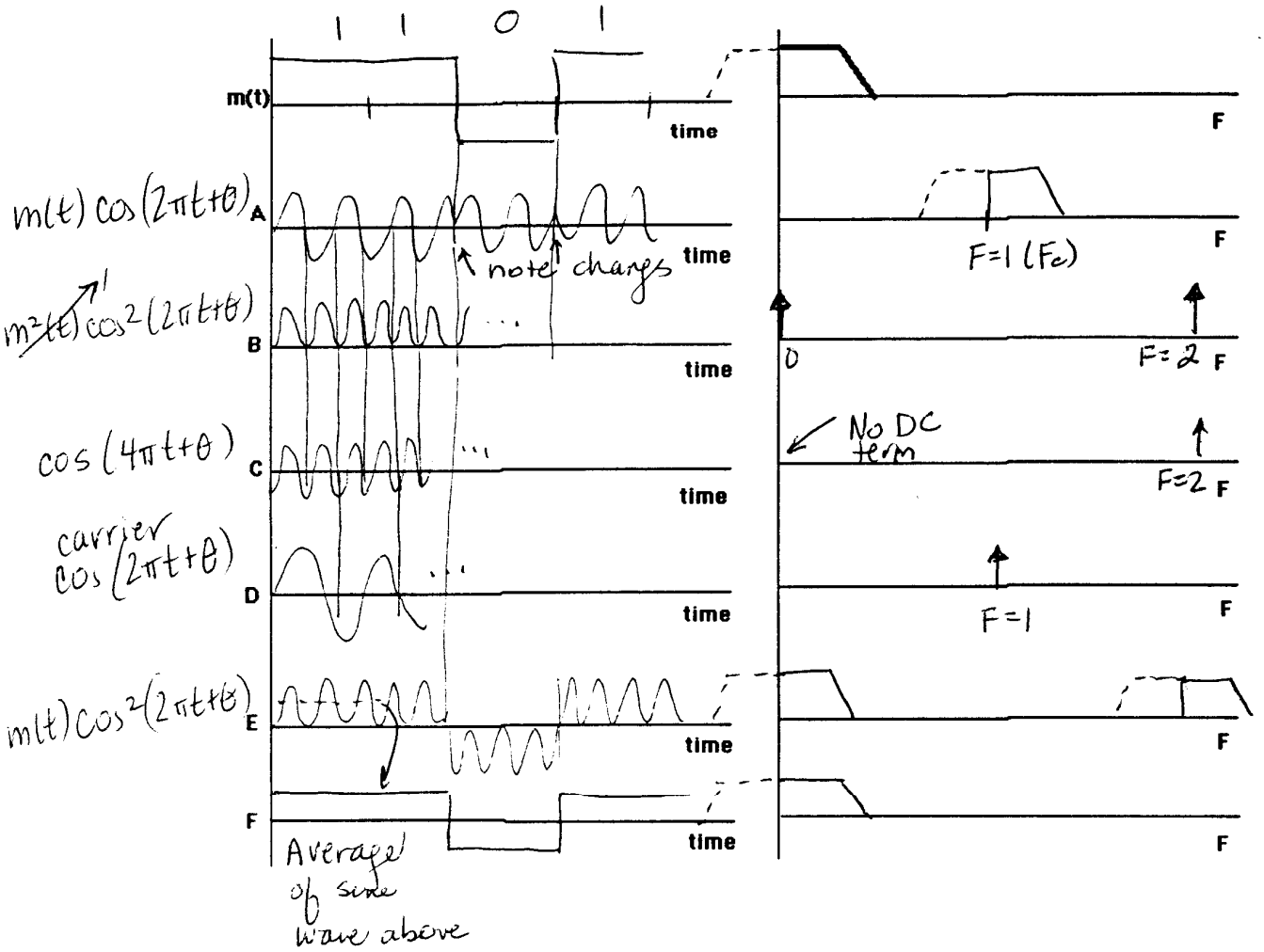
Specify the phase $\underline{\theta}$° of the cosine wave for the modulations below:

Method	1	1	0	1	1	0	0
BPSK	180°	180	0	180	180	0	0
DPSK	~~X~~ ?	0	1	1	1	0	1
	~~X~~ ?	0	180°	180°	180°	0	180°
QPSK	270°	270°	90°	90°	180°	180°	X

unknown

2. (33 points) A communication receiver is shown below. Sketch the time and frequency domain signals at every point indicated. If you need to include words to explain the signals, please do. The data stream m(t) = 1 1 0 1





3. (33 points)

(c) Sketch a simplified DSSS transmitter and receiver. LABEL each node. (You can use the same node name for receiver and transmitter any place that the signals would be equal.

(d) Explain what signal is at each node in both TIME and FREQUENCY domains.

(e) Demonstrate how a PN 1 code is used to retrieve Data 1

Transmitter:

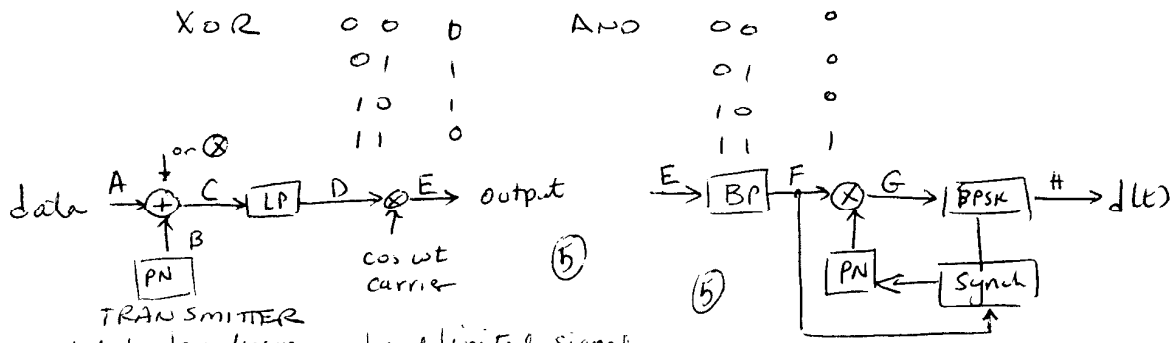
PN 1	1	1	0	1	0	0	1	1	1	0	0	0	1
Data 1	1												
(A) XOR PN1 & Data 1	0	0	1	0	1	1	0	0	0	1	1	1	0
PN 2	1	0	1	1	1	0	0	0	1	1	0	0	1
Data 2	0												
(B) XOR PN2 & Data 2	1	0	1	1	1	0	0	0	1	1	0	0	1
(A) AND (B) TXsignal	0	0	1	0	1	0	0	0	0	1	0	0	0

4 4

Receiver:

PN 1	1	1	0	1	0	0	1	1	1	0	0	0	1
RXsignal	0	0	1	0	1	0	0	0	0	1	0	0	0
XOR PN1 & RXsignal	1	1	0	1	0	0	1	1	1	1	0	0	1
Data 1?	A - 1's B - 0's → "1"												

4 4



(A) Original data, low frequency, band limited signal
(B) PN code, higher frequency digital signal
(C) data modulated by PN code, from using XOR. The "data" rate is now the "chip rate", so (C) has the same frequency range as (B)
(D) Keep only the lower sideband, near DC
(E) Data/PN Code stream modulated by the carrier. Frequency includes DC & high carrier frequency. Bandwidth is the same as (D)
(F) Band pass filtered version of DSSS (E) signal to remove DC offset & noise
(G) Original data demodulated by PN code, but still modulated by sine wave
(H) Original data

Note carrier recovery circuit explanation found in problem 2 if needed.