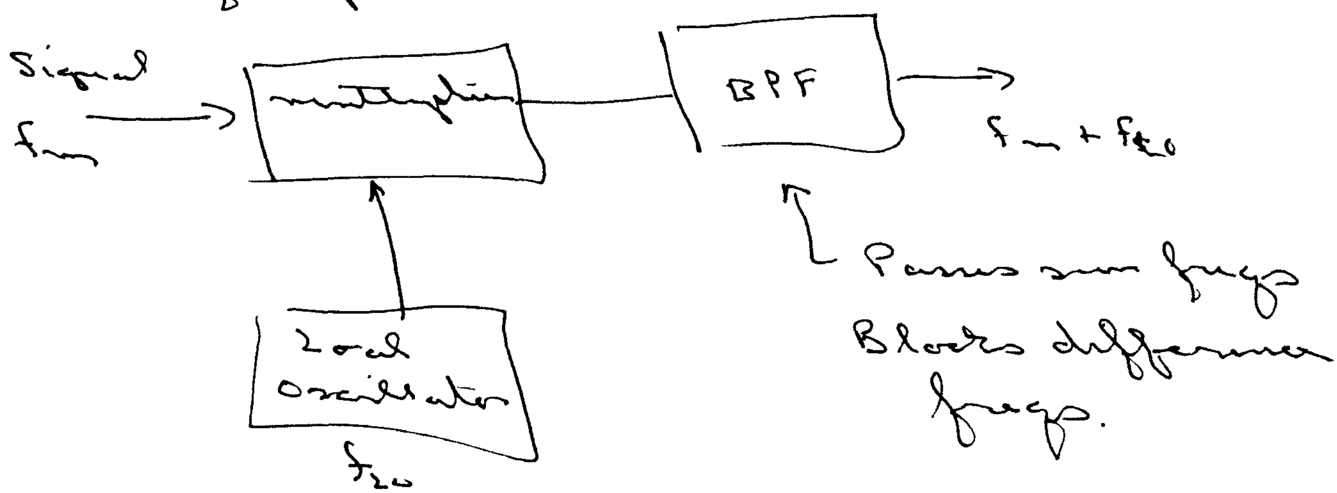
1) a) automatic gain control senses the signal strength in one part of the receiver and controls the amplification (or gain) in an other part of the circuit. Weak signal gives large gain; strong signal gives small gain.

b) Freq upconverter



c) $C = 4\ \text{Mb/s} \quad B = 30 \times 10^6 \quad SNR[dB] = ?$

$$C = 3.32 B \log(1 + SNR)$$

$$(4 \times \cancel{10^6}) = 3.32(30 \times \cancel{10^6}) \log(1 + SNR)$$

$$\frac{4}{(3.32)(30)} = 0.040 = \log(1 + SNR)$$

$$1 + SNR = 10^{0.40} = 1.096$$

$$SNR = 1.096 - 1 = 0.096$$

$$SNR[dB] = 10 \log SNR = 10 \log(0.096) = \underline{\underline{-10.18\,dB}}$$

2. a) $R = 10\ \text{Mb/s}$

$A = 60\%$

$C = 1\times10^9$

$$N' = \frac{C}{RA} = \frac{1\times10^9}{(10^7)(0.6)} = 166.7 \Rightarrow \boxed{166 \text{ users}}$$

b) $f_m = 10\ \text{kHz}$

$\Delta f = 30\ \text{kHz}$

$$m = \frac{\Delta f}{f_m} = \frac{30}{10} = 3$$

From Bessel Table, $m=3$ row, largest value on row is 0.4861. There are 6 significant sidebands that are bigger than $\frac{1}{100}\times 0.4861 = 0.004861$.

So,

$$B_{FM} = 2\cdot6\cdot f_m = 2\cdot6\cdot10\ \text{kHz}$$

$$\boxed{B_{FM} = 120\ \text{kHz}}$$

c) $f_B = 10\ \text{kHz}$

$$f_s = 6\underbrace{(2f_B)}_{\text{Nyquist sample rate}} = 120\ \text{ksamples/s}$$

$$R = nf_s = 12(120) = \underline{\underline{1440\ \text{kb/s}}} = \underline{\underline{1.44\ \text{Mb/s}}}$$

3) FM RCVR

From curve, for $m=1$, $SNR_{post} = 44$ dB, we find that $SNR_{pre} = 27$ dB (or so)

$SNR_{in} = SNR_{pre} + NF = 27 + 6 = 33$ dB

$$SNR_{in} = \frac{S_{in}}{N_{in}}$$

$$SNR_{in}[dB] = S_{in}[dBm] - N_{in}[dBm]$$

$$N_{in}[dBm] = 10\log\left(\frac{KTB}{1\times10^{-3}}\right)$$

$$= 10\log\underbrace{\left[\frac{(1.38\times10^{-23})(100)(220\times10^{3})}{1\times10^{-3}}\right]}_{3.03\times10^{-13}}$$

$$= -125.2 \text{ dBm}$$

$$SNR_{in}[dB] = 33 = S_{in}[dBm] - (-125.2 \text{ dBm})$$

$$S_{in}[dBm] = 33 - 125.2$$

$$\boxed{S_{in}[dBm] = -92.2 \text{ dBm}}$$

[See p. 289, Ex. 7.2 of Tomasi for similar problem]

4.) $H(f) = 15 \text{ sinc}(5f)$

$x(t) = 5\,\delta(t-3)$

a) $X(f) = ?$

From Fourier Transform Table

$X(f) = 5e^{-j(2\pi f)(+3)} = \underline{\underline{5e^{-j6\pi f}}}$

b) $Y(f) = ?$

$Y(f) = X(f)H(f) = 5e^{-j6\pi f} \cdot 15 \text{ sinc}(5f)$

$= \underline{\underline{75 e^{-j6\pi f} \text{ sinc } 5(f)}}$

c) $y(t) = ?$

$y(t) = \mathcal{F}^{-1}\left\{ 75 e^{-j6\pi f} \text{ sinc}(5f) \right\}$

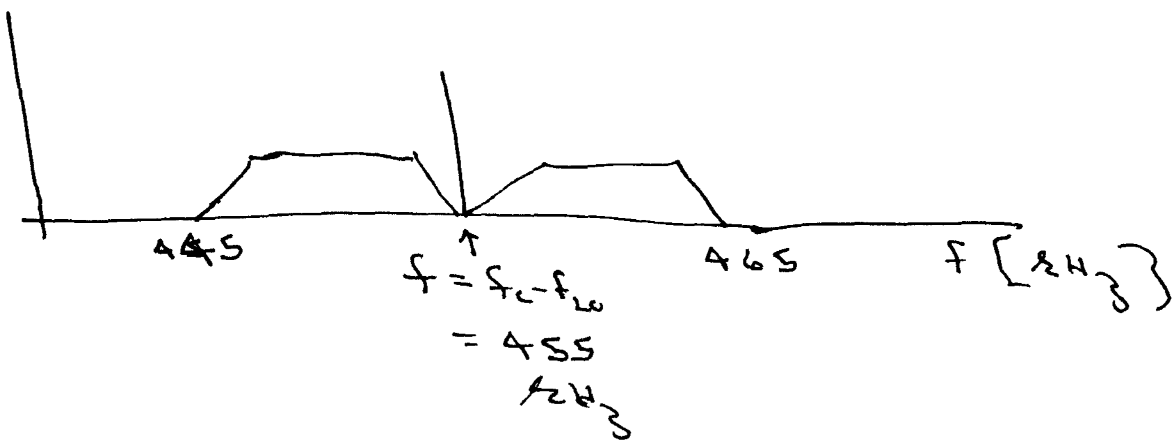
$= \mathcal{F}^{-1}\left\{ 15 \underbrace{e^{-j6\pi f}}_{\text{Time shift of } +3} \underbrace{5 \text{ sinc } 5f}_{\text{rect}\left(\frac{t}{5}\right)} \right\}$

$$\boxed{y(t) = 15 \text{ rect}\left(\frac{t-3}{5}\right)}$$

Note: ① almost the same problem as Exam I (different $H(f)$)

② $\mathcal{F}^{-1}\{ X_1(f) X_2(f) \} \neq x_1(t) x_2(t)$

5)
a) B is the output of a frequency downconverter



b) C is the output of the audio detector.
The audio detector removes the IF frequencies & produces the message.