# Scilab Textbook Companion for Electronic Communication Systems: Fundamentals Through Advanced by W. Tomasi[1]

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# Book Description

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Scilab numbering policy used in this document and the relation to the above book.

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

**AP** Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

# Contents


List of Scilab Codes 4

1 Introduction to Electronic Communciations 5

2 Signal Analysis and Mixing 22

3 Oscillator Phase Locked Loops and Frequency Synthesizer 23

4 Amplitude Modulation Transmission 27

5 Amplitude Modulation Reception 38

6 Single Sideband Communication Systems 47

7 Angle Modulation Transmission 53

8 Angle Modulation Reception and FM Stereo 66

9 Digital Modulation 70

10 Digital Transmission 74

12 Metallic Cable Transmission Media 79

13 Optical Fiber Transmission Media 86

14 Electromagnetic Wave Propagation 92

15 Antennas and Waveguides 95

**17 The Telephone Circuit** **104**

**19 Cellular Telephone Concepts** **106**

**20 Cellular Telephone Systems** **110**

**24 Microwave Radio Communications and System Gain** **112**

**25 Satellite Communication** **118**

# List of Scilab Codes

| | | |
|---|---|---|
| Exa 1.1 | Convert the absolute power ratio of 200 to a power gain in dB | 5 |
| Exa 1.3 | Convert the following absolute powers to dBm | 6 |
| Exa 1.4 | Convert the following into absolute power | 6 |
| Exa 1.5 | Determine The input power in dBm output power in watts and dBm the dB gain of each of the three stages and the overall gain in dB | 7 |
| Exa 1.6 | Find the overall of the threestage system in dB the output power of the system in dBm for an input power of 100uW | 9 |
| Exa 1.7 | Determine the total power when a signal with a power level if 20dBm is combined with a second signal of with a power level of 21dBm | 10 |
| Exa 1.8 | Determine the corresponding wavelength ranges for the following ITUT specified frequecny bands Medium Frequenices Ultra High Frequenices Very High Frequencies | 11 |
| Exa 1.9 | Determine the Shannon limit for information capacity | 12 |
| Exa 1.10 | Convert the following temperatures in kelvin | 13 |
| Exa 1.11 | Determine thermal noise power in watts and dBm rms noise voltage for 100 ohm internal resistance and 100 ohm load resistance | 13 |
| Exa 1.12 | Determine 2nd 3rd and 12th Harmonics for a 1kHz repeative wave percent second order third order and total harmonics distortion | 14 |
| Exa 1.13 | Determine first three harmonics present in the output for each input frequency cross product frequencies produced for value m and of 1 and 2 | 16 |

Exa 1.14 Determine the information carrying capacity of a communication channel if the bandwidth of the channel is 100MHz and signal to noise ratio is 30dB and signal to noise ratio is increased by 4 times over 30dB . . . . . 16
Exa 1.15 Determine the signal to noise power ratio . . . . . . . 17
Exa 1.16 Determine Input SN ratio Output SN ratio Noise factor and noise figure . . . . . . . . . . . . . . . . . . . . . . 18
Exa 1.17 Determine the total noise figure . . . . . . . . . . . . . 20
Exa 1.18 Determine noise figure for an equivalent noise temperature of 75 K and equivalent noise temperature for a noise figure of 6dB . . . . . . . . . . . . . . . . . . . . 20
Exa 2.3 Determine the dc component the peak amplitude of the 10 harmonics plot the sin x by x function sketch the frequency spectrum . . . . . . . . . . . . . . . . . . . . 22
Exa 3.1 Determine the frequency of operation if the temperature increases by 10 degree C decreases by 5 degree C . . . 23
Exa 3.2 Determine PLL open loop gain change in VCO frequency necessary to achieve lock PLL output voltage phase detector output voltage static phase error . . . . . . . . 24
Exa 4.1 Determine frequency limits for the upper and lower sidebands bandwidth upper and lower side frequencies produced when the modulating signal is a single frequency 3kHz tone draw the frequency spectrum . . . . . . . . 27
Exa 4.2 Determine upper and lower frequencies modulation coefficient and percent modulation peak amplitude of the modulation carrier and the upper and lower side frequency voltages maximum and minimum amplitudes of the envelope . . . . . . . . . . . . . . . . . . . . . . . . 29
Exa 4.3 Obtain the total average power of the modulated signal in dB watts and dBm the peak and RMS voltages of the modulated signal . . . . . . . . . . . . . . . . . . . . . 31
Exa 4.4 Determine 1 power of the carrier and the upper and lower sidebands 2 total sideband power 3 total power of the modulated wave 4 change m for 1 to 3 . . . . . . . 32
Exa 4.5 Find the power in each sideband of a DSBFC signal . 34
Exa 4.6 Determine 1 maximum and minimum voltage gains 2 maximum and minimum amplitude for Vout . . . . . . 35

Exa 4.7 Determine carrier frequency AND upper and lower side frequencies . . . . . . . . . . . . . . . . . . . . . . . . . 36
Exa 5.1 Determine the improvement in the noise figure for a receiver with an RF bandwidth equal to 200kHz and an IF bandwidth equal to 10kHz . . . . . . . . . . . . . . . 38
Exa 5.2 Determine the bandwidth at the low and high ends of RF spectrum . . . . . . . . . . . . . . . . . . . . . . . 39
Exa 5.3 Determine the IF carrier upper side frequency and lower side frequency . . . . . . . . . . . . . . . . . . . . . . . 39
Exa 5.5 Determine 1 image frequency 2 image frequency rejection ratio for a Q of 120 for the tuned circuit in the preselector of the receiver 3 IFRR if the preselector of 2 is followed by another RF tuned of IFR . . . . . . . . 40
Exa 5.6 Determine 1 local oscillator frequency 2 image frequency 3 IFRR for a preselector Q of 160 4 preselector Q required to achieve the IFRR as that achieved for an RF carrier of 600kHz . . . . . . . . . . . . . . . . . . . . . . 42
Exa 5.7 Calculate 2 IFRR 2 IFRR in dB 3 IFRR for an IF of 455kHz 4 Q of primary and secondary circuit of the IF transformer is 40 and 50 so find critcal coupling factor 43
Exa 5.8 Determine the net receiver gain and the audio signal level 45
Exa 6.1 Determine the quality factor necessary for a single sideband filter with a 1MHz carrier frequency 80dB unwanted sideband suppression and the following frequency spectrum . . . . . . . . . . . . . . . . . . . . . . . . . 47
Exa 6.2 Determine demodulated first IF frequency band and demodulated information frequency band and demodulated information frequency band if the RF local oscillator frequency drift . . . . . . . . . . . . . . . . . . . . 48
Exa 6.3 Determine the demodulated first IF frequency band and demodulated information frequency band and demodulated information frequency band . . . . . . . . . . . . 49
Exa 6.4 Determine for a single sideband suppressed carrier transmission the output frequency spectrum and a load resistance and the PEP and average power . . . . . . . . 51
Exa 7.1 Determine 1 the peak frequency deviation and modulation index for an FM modulator 2 the peak phase deviation for a PM modulation . . . . . . . . . . . . . . . . 53

Exa 7.2 Determine 1 carrier frequency 2 modulation frequency 3 modulation index 4 peak phase deviation . . . . . . 54
Exa 7.3 Determine 1 Number of sets of significant side frequenices 2 Amplitude of the frequencies 3 Draw the spectrum . 55
Exa 7.4 Determine 1 actual minimum bandwidth from the Bessel function table 2 approximate minimum bandwidth using Carsons rule 3 plot the output frequency spectrum for the Bessel approximation . . . . . . . . . . . . . . . 56
Exa 7.5 Determine the deviation ratio and bandwidth for 1 the worst case modulation index 2 an equal modulation index 58
Exa 7.6 Determine 1 the modulation indexes and sketch the output spectrum 2 change the modulating signal amplitude to 4Vp for 1 3 change the modulating signal frequency to 1kHz for 1 . . . . . . . . . . . . . . . . . . . . . . . . 59
Exa 7.7 Determine 1 the unmodulated carrier power for the FM modulator 2 the total power in the angle modulated wave 61
Exa 7.8 Determine 1 frequency of the demodulated interference signal 2 peak phase and frequency deviations due to the interfering signal 3 voltage signal to noise ratio at the output of the demodulator . . . . . . . . . . . . . . . . 62
Exa 7.11 Determine 1 master oscillator centre frequency 2 frequency deviation at output for a frequency deviation of 75kHz at antenna 3 deviation ratio for fm 4 deviation ratio of antenna . . . . . . . . . . . . . . . . . . . . . 64
Exa 8.1 Determine the peak output voltage . . . . . . . . . . . 66
Exa 8.2 Determin the minimum receive carrier power necessary to achieve a postdetection signal to noise ratio 37dB . 67
Exa 8.3 Determine the pre and postdetection SN ratios . . . . 68
Exa 8.4 Determine the minimum receive signal level . . . . . . 68
Exa 9.2 Determine the peak frequency deviation minimum bandwidth baud rate for a binary FSK signal . . . . . . . . 70
Exa 9.3 Determine the minimum bandwidth for the FSK signal 71
Exa 9.15 Determine the minimum bandwidth required . . . . . 72
Exa 10.1 Determine the largest value capacitor that can be used in figure . . . . . . . . . . . . . . . . . . . . . . . . . . 74
Exa 10.3 Determine the quantized voltage quantization error and PCM code . . . . . . . . . . . . . . . . . . . . . . . . 75

Exa 10.4 Calculate 1 the resolution and quantization error 2 the coding efficiency for a resolution . . . . . . . . . . . . 76
Exa 10.8 Determine the minimum line speed in bits per second to transmit speech signal of 1 a 7 bit PCM 2 an 8 bit PCM . . . . . . . . . . . . . . . . . . . . . . . . . 77
Exa 12.1 Determine the characteristic impedance for an air dielectric two wire parallel transmission line . . . . . . . 79
Exa 12.2 Determine the characteristic impedence for coaxial cable 80
Exa 12.3 Charecteristic impedence for RG-59A coaxial cable . . 80
Exa 12.4 Determine the velocity of propagation and the velocity factor . . . . . . . . . . . . . . . . . . . . . . . . . 81
Exa 12.5 Determine reflection coefficient and SWR . . . . . . . 82
Exa 12.6 Determine the physical length and characterictic impedence for a quarter wavelength transformer . . . . . . 83
Exa 12.7 How far down the cable is the impairment . . . . . . . 84
Exa 12.8 Determine the time elapsed from the beginning of the pulse to the reception of the echo . . . . . . . . . . . . 84
Exa 13.1 Determine the angle of refraction . . . . . . . . . . . . 86
Exa 13.2 Calculate the refractive index of the cladding . . . . . 87
Exa 13.3 Calculated the optical power . . . . . . . . . . . . . . 88
Exa 13.4 Calculate the maximum data rate through a 6 km long step index fibre . . . . . . . . . . . . . . . . . . . . . . 88
Exa 13.5 Determine the maximum digital transmission rates for return to zero and nonreturn to zero . . . . . . . . . . 89
Exa 13.6 Determine th optical power received in dBm and watts 90
Exa 14.1 Determine power density from source at 1000m and 2000m 92
Exa 14.2 Determine the height of the receiving antenna and the maximum transmission distance . . . . . . . . . . . . 93
Exa 14.3 Determine the fade margin . . . . . . . . . . . . . . . 94
Exa 15.1 Determine antenna efficiency antenna gain radiated power in watts dBm dBW and EIRP in watts dBm dBW . . 95
Exa 15.2 Determine the antenna input radiated power EIRP and receive power density . . . . . . . . . . . . . . . . . . 97
Exa 15.3 Determine captured power in dBm and watts . . . . . 99
Exa 15.4 Determine beamwidth transmit and receive power gain and EIRP . . . . . . . . . . . . . . . . . . . . . . . . . 100
Exa 15.5 Determine Cutoff frequency and wavelength group and phase velocity . . . . . . . . . . . . . . . . . . . . . . . 101

Exa 15.6 Determine the cutoff frequency and the characteristic of TE10 . . . 103
Exa 17.1 Determine the power level in dBm and the difference between them . . . 104
Exa 19.1 Determine the number of channels per cluster and total channel capacity . . . 106
Exa 19.2 Determine for a cell area . . . 107
Exa 19.3 Determine the following . . . 108
Exa 20.1 Determine the transmit and receive carrier frequencies for AMPS channels 3 and 91 . . . 110
Exa 20.2 Determine the transmit power for a CDMA . . . 111
Exa 24.1 Determine the free space path loss in dB . . . 112
Exa 24.2 Determine the frequency of operation of the microwave link . . . 113
Exa 24.3 Determine the noise power . . . 114
Exa 24.4 Determine the minimum receive carrier power and the minimum transmit power . . . 115
Exa 24.5 Determine the following . . . 115
Exa 25.2 Determine the energy per bit for a transmission rate of 50Mbps . . . 118
Exa 25.5 Determine the noise density and equivalent noise temperature . . . 119

# Chapter 1

# Introduction to Electronic Communciations

**Scilab code Exa 1.1** Convert the absolute power ratio of 200 to a power gain in dB

```
clc
//Example 1.1
//Page no 6

//Solution

disp("Substituting into Eq 1.3 (ref pg no 4) yeilds,
   ");

ap=10*log10(200);    //absolute power ratio in dB

disp('dB',ap,"The absolute power ratio is:");

//absolute ratio: 200 = 100 X 2"

disp("Applying the product rule for logarithms, the
   power gain in dB is:");

```

```
Ap=10*log10(100)+10*log10(2);   //power gain in dB

//Result
disp('dB',Ap,"The power gain is, ")
```

**Scilab code Exa 1.3** Convert the following absolute powers to dBm

```
clc;
//Example 1.3
//Page no 8

//Solution

//(a)

dBm1=10*log10([500*(10^-3)]/[1*(10^-3)]);

disp('dBm',dBm1,"(a) 500 mW in dbm = ");

//(b)

dBm2=10*log10([10*(10^-9)]/[1*(10^-3)]);

disp('dBm',dBm2,"(b) 10 nW in dbm = ");

//(c)

dBm3=10*log10([100*(10^-6)]/[1*(10^-3)]);

disp('dBm',dBm3,"(c) 100 uW in dbm = ");
```

**Scilab code Exa 1.4** Convert the following into absolute power

```
clc;
//Example 1.4
//Page no 8

//Solution

//(a)

p1=(10^-2.7)*(10^-3);

disp('W', p1,"-27dBm in absolute power is, ");

//(b)

p2=(10^1.3)*(10^-3);

disp('W', p2,"13dBm in absolute power is, ");

//(c)

p3=(10^4)*(10^-3);

disp('W', p3,"40dBm in absolute power is, ");

//(d)

p4=(10^-5.3)*(10^-3);

disp('W', p4,"-53dBm in absolute power is, ");
```

**Scilab code Exa 1.5** Determine The input power in dBm output power in watts and dBm the dB gain of each of the three stages and the overall gain in dB

```
clc;
```

```
//Example 1.5
//Page no 9



pin=0.1*(10^-3);
ap1=100;
ap2=40;
ap3=0.25;

//Solution

//(a)

disp("(a)The input power in dBm ");

Pin=10*log10(pin/0.001);

disp('dBm',Pin,"The input power in dBm is, ");

//(b)

disp("(b)The output power is simply the input power
    multiplied by the three power gains: ");

Pout=(pin)*ap1*ap2*ap3;

Pout1=10*log10(Pout/0.001);

disp('dBm',Pout1,'W',Pout,"The output power in watts
    and dBm is,");

//(c)

disp("(c)The decibel value for the three gains are
    determined by substituting into equation 1-3 (
    Pgno 4)");

```

```
Ap1=10*log10(ap1);
disp('dB',Ap1,"Ap1 = ");
Ap2=10*log10(ap2);
disp('dB',Ap2,"Ap2 = ");
Ap3=10*log10(ap3);
disp('dB',Ap3,"Ap3 = ");
//(d)
disp("(d)The overall power gain in dB (Apr) can be determined by simply adding the individual dB power gains, ");
Apr=Ap1+Ap2+Ap3;
disp('dB',Apr,"Apr = ");
disp("The output power in dBm is the input power in dBm plus the sum of the gains of the three stages: ");
Pout2=Pin+Apr;
disp('dBm',Pout2,"Pout = ");
```

**Scilab code Exa 1.6** Find the overall of the threestage system in dB the output power of the system in dBm for an input power of 100uW

```
clc;
//Example 1.6
```

```
//Page no 10



//Solution

//(a)

a=100*5

disp(a,"(a)Overall gain of the system is the product
    of the individual gain, that is ");

ap=10*log10(a);

disp('dB',ap,"Thus, the overall gain in dB is,")

//(b)

b=[100*(10^-6)]*500;

disp('W',b,"(b)Output power = Input power to the
   system X Overall power gain, that is ")

bp=10*log10(b/[1*(10^-3)]);

disp('dBm', bp,"Therefore, Output power expressed in
    dB is, ");
```

**Scilab code Exa 1.7** Determine the total power when a signal with a power level if 20dBm is combined with a second signal of with a power level of 21dBm

```
clc;
//Example 1.7
```

```
//Page no 11
//Solution

a=21+2.5;

disp('dBm',a,"The difference in the two power levels
     is 1 dB. Therefore, from table 1-5 , the
    combining term is 2.5 dB and the total power is,
    ");
```

**Scilab code Exa 1.8** Determine the corresponding wavelength ranges for the following ITUT specified frequecny bands Medium Frequenices Ultra High Frequenices Very High Frequencies

```
clc;
//Example 1.8
//Page no 17

//Solution

//Refer to figure 1-5 on page no 17

//(a)

disp("(a)Medium Frequencies as per ITU-T range
    between 0.3MHz and 3MHz.");

lm1=([3*(10^8)]/[0.3*(10^6)]);

lm2=([3*(10^8)]/[3*(10^6)]);

disp('m',lm2,'and','m',lm1,"Therefore, wavelengths
    range for MF are between ");

//(b)
```

```

disp("(b)Ultra High Frequencies as per ITU-T range
    between 300MHz and 3GHz.");

lm3=([3*(10^8)]/[300*(10^6)]);

lm4=([3*(10^8)]/[3*(10^9)]);

disp('m',lm4,'and','m',lm3,"Therefore, wavelengths
    range for UHF are between ");

//(c)

disp("(c)Very High Frequencies as per ITU-T range
    between 30MHz and 300Mz.");

lm5=([3*(10^8)]/[30*(10^6)]);

lm6=([3*(10^8)]/[300*(10^6)]);

disp('m',lm6,'and','m',lm5,"Therefore, wavelengths
    range for VHF are between ");
```

**Scilab code Exa 1.9** Determine the Shannon limit for information capacity

```
clc;
//Example 1.9
//Page no 20



//Solution

disp("The Shannon limit for capacity is determined
```

```
    by substituting into equation 1−12b");

I=(3.32)*(2700)*log10(1+1000);

disp('bps',I);
```

**Scilab code Exa 1.10** Convert the following temperatures in kelvin

```
clc;
//Example 1.10
//Page no 22

//Solution

disp("The formula T = C+273 is used to convert
    degree C into Kelvin. ");

T1=100+273;
T2=0+273;
T3=-10+273;

disp('K',T1,"(a) ");
disp('K',T2,"(b) ");
disp('K',T3,"(c) ");
```

**Scilab code Exa 1.11** Determine thermal noise power in watts and dBm rms noise voltage for 100 ohm internal resistance and 100 ohm load resistance

```
clc;
//Example 1.11
//Page no 24

//Solution
```

```

R=100;

T=17+273;

N=([1.38*(10^-23)]*[T]*[1*(10^4)]);

disp('W',N,"N = ");

disp("Substituting in equation 1-16 (refer pgno 23) give the noise power in dBm: ");

N1=-174+[10*log10(10000)];

disp('dBm',N1,"N = ");

//(b)

disp("(b)The rms noise voltage is found by substituting into equation 1-17 (refer pgno 23): ");

V=sqrt(4*R*N);

disp('V',V,"Vn = ");
```

**Scilab code Exa 1.12** Determine 2nd 3rd and 12th Harmonics for a 1kHz repeative wave percent second order third order and total harmonics distortion

```
clc;
//Example 1.12
//Page no 25


```

```
//Solution

V1=8;
V2=0.2;
V3=0.1;

//(a)


h1=2*1;

disp('kHz',h1,"2nd harmonic = ");

h2=3*1;

disp('kHz',h2,"3rd harmonic = ");

h3=12*1;

disp('kHz',h3,"12th harmonic = ");

//(b)

disp("(b) ")

p1=(V2/V1)*100;

disp('%',p1,"%2nd order = ");

p2=(V3/V1)*100;

disp('%',p2,"%3nd order = ");

THD=([sqrt((0.2^2)+(0.1^2)) ]/8)*100;

disp('%',THD," Total harmonic distortion = ");
```

**Scilab code Exa 1.13** Determine first three harmonics present in the output for each input frequency cross product frequencies produced for value m and of 1 and 2

```
clc;
//Example 1.13
//Page no 26

//Theory
```

**Scilab code Exa 1.14** Determine the information carrying capacity of a communication channel if the bandwidth of the channel is 100MHz and signal to noise ratio is 30dB and signal to noise ratio is increased by 4 times over 30dB

```
clc;
//Example 1.14
//Page no 27


//solution:

//(a)
disp("Given B=100MHZ, S/N= 30dB = 1000");



B=(100*(10^6));
Sn=1000;

I=3.32*B*log10(Sn+1);

```

```
disp('bps',I,"I = ");

//(b)

disp("(b)If the SNR is increased by 4 times, the new
   ")

SNR=Sn*4;

disp(SNR,"SNR = ");

i=3.32*B*log10(SNR+1);

disp('bps',i,"Therefore, the new information
   carrying capactiy is ")
```

**Scilab code Exa 1.15** Determine the signal to noise power ratio

```
clc;
//Example 1.15
//Page no 28


//solution

v1=4;

v2=0.005;



sn=20*log10(v1/v2);

disp('dB',sn,"S/N = ");
```

**Scilab code Exa 1.16** Determine Input SN ratio Output SN ratio Noise factor and noise figure

```
clc;
//Example 1.16
//Page no 30


disp("Given: For a non ideal amplifier and the following parameters ");
disp("Input signal power = 2 x 10^-10 W");
disp("Input noise power = 2 x 10^-18 W");
disp("Power Gain = 1 x 10^6");
disp("Internal noise = 6 x 10^-12 W");

//Solution

ip=2*(10^-10);

in=2*(10^-18);

G=1*(10^6);

Nd= 6*(10^-12);

//(a)


sn=(ip/in);

SN=10*log10(round(sn));

disp('dB',round(SN),"S/N = ");

```

```
//(b)

disp("(b)The output noise power is the sum of the
    internal noise and the amplified input noise,
    therefore ");

No=(G*in)+Nd;

disp('W',No,"Nout = ");

disp("The output power is simply the product of the
    input power and the power gain. ");

Po=G*ip;

disp('W',Po,"Pout = ");

disp("For the output signal and noise power levels
    calculated and substituting in equation 1-22, the
     output S/N is ");

sn1=(Po/No);

SN1=10*log10(round(sn1));

disp('dB',round(SN1),"S/N = ");

//(C)

disp("(c)The noise factor is found by substituting
    the result from step (a) and (b) into equation
    1-25  ");

F=([round(sn)]/[round(sn1)]);

disp(F,"F = ");

disp("and the noise figure is calculated from
```

```
    equation 1-26(refer pgno 25) ");

NF=10*log10(round(F));

disp('dB',round(NF),"NF = ");
```

**Scilab code Exa 1.17** Determine the total noise figure

```
clc;
//Example 1.17
//Page no 31



//solution



ft=2+((2-1)/10)+([2-1]/100);//Noise factor

disp(ft,"Ft = ")

disp("Thus, the total noise figure is");

nft=10*log10(ft);

disp('dB',nft,"NFt = ")
```

**Scilab code Exa 1.18** Determine noise figure for an equivalent noise temperature of 75 K and equivalent noise temperature for a noise figure of 6dB

```
clc;
//Example 1.18
```

```
//Page no 33

//solution

//(a)

Te=75;

T=290;



f=1+(Te/T);//Noise factor

disp(f,"F = ");

nf=10*log10(f);

disp('dB',round(nf),"NF = ");

//(b)

disp("(b)Noise factor is found by rearranging
    equation 1-26 ");

F=10^0.6;

disp(round(F),"F = ");

disp("substituting into equation 1-31 gives, ")

te=T*(round(F)-1);

disp('K',round(te),"Te = ");
```

# Chapter 2

# Signal Analysis and Mixing

**Scilab code Exa 2.3** Determine the dc component the peak amplitude of the 10 harmonics plot the sin x by x function sketch the frequency spectrum

```
clc;
//Example 2.3
//Page no 50

disp("For the pulse waveform shown in figure 2.12 (
   refer pgno 50)");

//Solution

//(a)

disp("(a)From Equation 2-16 (refer pgno 49), the dc
   component is ");

v=([1*{0.4*(10^-3)}/{2*(10^-3)}]);

disp('V',v,"V0 = ");
```

# Chapter 3

# Oscillator Phase Locked Loops and Frequency Synthesizer

**Scilab code Exa 3.1** Determine the frequency of operation if the temperature increases by 10 degree C decreases by 5 degree C

```
clc;
//Example 3.1
//Page no 75



//Solution

fn=10*(10^6);
k=10;
c1=10;
c2=-5;

//(a)

disp("(a)Substituting into equation 3-6 and 3-7 (
   refer pgno 75) give us ");

```

```
df=k*(10*c1);

disp('Hz',round(df),"dF = ");

fo=fn+(round(df));

disp('MHz',fo/(10^6),"F0 = ");

//(b)

disp("(b)Again, substituting into equation 3-6 and
   3-7 yields ");

dF=k*(10*c2);

disp('Hz',round(dF),"dF = ");

f1=fn+(round(dF));

disp('MHz',f1/(10^6),"F0 = ");
```

**Scilab code Exa 3.2** Determine PLL open loop gain change in VCO frequency necessary to achieve lock PLL output voltage phase detector output voltage static phase error

```
clc;
//Example 3.2
//Page no 96


//Solution

fn=200*(10^3);
fi=210*(10^3);
Kd=0.2;
```

```
Kf=1;
Ka=5;
Ko=20;

//(a)

disp("(a)From equation 3-20 and 3-21 (refer pgno 95), we get ");

Kl=Kd*Kf*Ka*Ko;

disp('kHz/rad',Kl,"Kl = ");

Kv=2*(%pi)*(Kl*(10^3));

disp('rad/s',Kv,"Kv = ");

KV=20*log10(Kv);

disp('dB',round(KV),"Kv(dB) = ");

//(b)

dF=fi-fn;

disp('kHz',(dF/(10^3)),"(b)dF = ");

//(c)

disp("(c)Rearranging equation 3-15 (refer pgno 89) gives us ");

Vo=((dF/(10^3))/Ko);

disp('V',Vo,"Vout = ");

Vd=(Vo/(Kf*Ka));

```

```
disp('V',Vd,"Vd = ");

//(d)

disp("(d)Rearranging equation 3-18 (refer pgno 94)
    gives us ");

the=(Vd/Kd);

disp('rad',the,"THe = ");
```

# Chapter 4

# Amplitude Modulation Transmission

**Scilab code Exa 4.1** Determine frequency limits for the upper and lower sidebands bandwidth upper and lower side frequencies produced when the modulating signal is a single frequency 3kHz tone draw the frequency spectrum

```
clc;
//Example 4.1
//Page no 118

disp("Given: For and AM DSBFC modulator with a
   carrier frequency Fc=100kHz and a maximum
   modulating signal frequency of Fm(max)=5kHz.");

//solution

Fc=100*(10^3);
Fm=5*(10^3);
fm=3*(10^3);

//(a)

```

```
disp("(a)The lower sideband extends from the lowest possible lower side frequency to the carrier frequency or ");

lsb=(Fc-Fm);

disp("kHz",(Fc/(10^3)),"kHz to",(lsb/(10^3)),"LSB = ");

disp("The upper sideband extends from the carrier frequency to the highest possible upper side frequency is ");

usb=(Fc+Fm);

disp("kHz",(usb/(10^3)),"kHz to",(Fc/(10^3)),"USB = ");

//(b)

disp("(b)The bandwidth is equal to the difference between the maximum upper side frequency and the minimum lower side frequency. ");

b=2*Fm;

disp("kHz",(b/(10^3)),"B = ");

//(c)

disp("(c)The upper side frequency is the sum of the carrier and modulating frequency.");

Fu=Fc+fm;

disp("kHz",(Fu/(10^3)),"Fusf = ");

disp("The lower side frequency is the difference
```

```
between the carrier and modulating frequency.");

Fl=Fc-fm;

disp("kHz",(Fl/(10^3)),"Flsf = ");

//(d)

disp("(d)The output frequency spectrum is shown in
   figure.");
```

**Scilab code Exa 4.2** Determine upper and lower frequencies modulation coefficient and percent modulation peak amplitude of the modulation carrier and the upper and lower side frequency voltages maximum and minimum amplitudes of the envelope

```
clc;
//Example 4.2
//Page no 123


//solution

Fc=500; //kHz
Fm=10; //kHz
Ec=20;
Em=7.5;

disp("(a)The upper and lower side frequencies are
   simply the sum and difference frequencies,
   respectively ");

fu=Fc+Fm;
fl=Fc-Fm;

```

```
disp('kHz',fl,'kHz and Flsf = ',fu,"Fusf = ");

//(b)

disp("(b)The modulation coefficient is determined
    from equation 4-1 (refer pgno 120)");

m=Em/Ec;

disp(m,"m = ");

disp("Percent modulation is determine from equation
    4-2 (refer pgno 120)");

M=100*m;

disp('%',M,"M = ");
//(c)

disp("(c)The peak amplitude of the modulated carrier
     and the upper and lower side frequencies is ");

eu=((m*Ec)/2);

disp('Vp',eu,"Eusf(modulated) = ");

//(d)

disp("(d)The maximum and minimum amplitude of the
    envelope are, ");

Vm=Ec+Em;
vm=Ec-Em;

disp('Vp',vm,'Vp and Vmin = ',Vm,"Vmax = ");
```

**Scilab code Exa 4.3** Obtain the total average power of the modulated signal in dB watts and dBm the peak and RMS voltages of the modulated signal

```
clc;
//Example 4.3
//Page no 128
//solution

Fc=1; //MHz
Fm=5; //kHz
M=60; //%
m=(M/100);
Pc=6; //KW


//(a)

disp("(a)Total average power delivered to the load "
   );

Rl=(Pc*[1+m^2/2]);

disp('KW',Rl,"Rl = ");

//(b)

disp("(b)The modulation signal power ");

Vs=sqrt(100*(10^3)*Rl);

disp('KV',(Vs/(10^3)),"Vs(RMS) = ");

a=Vs*sqrt(2);

```

```
disp('KV',(a/(10^3)),"Therefore, peak value of modulation signal =")
```

**Scilab code Exa 4.4** Determine 1 power of the carrier and the upper and lower sidebands 2 total sideband power 3 total power of the modulated wave 4 change m for 1 to 3

```
clc;
//Example 4.4
//Page no 128

Vc=10; //Vp
m=1;
Rl=10;
m1=0.5;

//(a)

disp("(a)The carrier power is found by substituting into equation 4-18 (pgno 126): ");

Pc=((Rl^2)/(2*Rl));

disp('W',Pc,"Pc = ");

disp("The upper and lower sideband power is found by substituting into equation 4-21 (pgno 127):");

P=(((m^2)*Pc)/4);

disp('W',P,"Pusb = Plsb = ");

//(b)

disp("(b)The total sideband power is ");
```

```
Ps=(((m^2)*Pc)/2);

disp('W',Ps,"Psbt = ");

//(c)

disp("(c)The total power in the modulated is found by substituting into equation 4-25 (pgno 127)");

Pt=(5*[1+(m^2)/2]);

disp('W',Pt,"Pt = ");

//(d)

disp("(d)The carrier power is found by substituting into equation 4-18 ");

Pc1=Pc;

disp('W',Pc1,"Pc ");

disp("The upper and lower sideband power is found by substituting into equation 4-21 (pgno 127):");

P1=(((m1^2)*Pc)/4);

disp('W',P1,"Pusb = Plsb = ");

disp("The total sideband power is ");

Ps1=(((m1^2)*Pc)/2);

disp('W',Ps1,"Psbt = ");

disp("The total power in the modulated is found by substituting into equation 4-25 (pgno 127)");
```

```

Pt1=(5*[1+(m1^2)/2]);

disp('W',Pt1,"Pt = ");
```

**Scilab code Exa 4.5** Find the power in each sideband of a DSBFC signal

```
clc;
//Example 4.5
//Page no 131

//Solution

Rl=100; //ohm
Fc=1;   //MHz
Fm1=2; //kHz
Fm2=3; //kHz
Fm3=5; //kHz
Ec=100; //V
Em1=10; //V
Em2=20; //V
Em3=30; //V

m1=(Em1/Ec);

disp(m1,"m1 = ");

m2=(Em2/Ec);

disp(m2,"m1 = ");

m3=(Em3/Ec);

disp(m3,"m1 = ");

```

```
m=sqrt((m1^2)+(m2^2)+(m3^2));

disp(m,"Overall modulation index m = ");

disp("Power in both the upper and lower sideband is
    same, which is given by ");

Psb=((Ec^2*m^2)/(2*Rl*4));

disp('W',Psb,"Psb = ");
```

**Scilab code Exa 4.6** Determine 1 maximum and minimum voltage gains 2 maximum and minimum amplitude for Vout

```
clc;
//Example 4.6
//Page no 133
//Solution

m=0.8;
Aq=100;
Fc=500; //kHz
Vc=5*(10^-3); //mV
Fm=1000; //Hz

//(a)

disp("(a)Substituting into equation 4-34(pgno 132),
    ");

Am=Aq*(1+m);

disp(Am," Amax = ");

am=Aq*(1-m);
```

```

disp(am,"Amin = ");

//(b)

Vom=Am*Vc;

vom=am*Vc;

disp('V',Vom,"(b)Vout(max) =  ");
disp('V',vom,"Vout(min) =  ");
```

**Scilab code Exa 4.7** Determine carrier frequency AND upper and lower side frequencies

```
clc;
//Example 4.7
//Page no 140
//solution

//(a)

V=12; //dc
Vm=2; //Vp
Fm=4; //kHz
Vb=4; //dc
R1=100*(10^3); //kohm
C1=0.001*(10^-6); //uF

//(a)

disp("(a)The carrier frequency is determine from
    equation 4-36(refer pgno 137): ");

fc=(1/(R1*C1));
```

```
Fc=fc/(10^2)

disp('kHz',Fc,"fc =  ");

//(b)

disp("(b)The upper and lower side frequency are
   simply the sum and difference frequencies between
    the carrier and the modulating signal.");

fu=Fc+Fm;

disp('kHz',fu,"Fusf =  ");

fl=Fc-Fm;

disp('kHz',fl,"Flsf =  ");
```

# Chapter 5

# Amplitude Modulation Reception

**Scilab code Exa 5.1** Determine the improvement in the noise figure for a receiver with an RF bandwidth equal to 200kHz and an IF bandwidth equal to 10kHz

```
clc;
//Example 5.1
//Page no 159

//solution

Brf=200; //kHz
Bif=10; //kHz

//Bandwidth improvement is found by substituting
   into equati
BI=(Brf/Bif);

disp(BI,"BI = ");

disp("and noise figure improvement is found by
   substituting into equation 5-3 (refer pgno 157)")
```

```
;

NF=10*log10(BI);

disp('dB',NF,"NF = ")
```

**Scilab code Exa 5.2** Determine the bandwidth at the low and high ends of RF spectrum

```
clc;
//Example 5.2
//Page no 161



//solution

Q=54;

disp("The bandwidth at the low frequency end ");

B=(540/Q);

disp('kHz',B,"B = ")

disp("The bandwidth at the high frequency end  ");

B1=(1600*(10^3)/Q);

disp('Hz',round(B1),"B = ")
```

**Scilab code Exa 5.3** Determine the IF carrier upper side frequency and lower side frequency

```
clc;
//Example 5.3
//Page no 165



//solution

fio=1355; //kHz
fRF=900; //kHz
fRFu=895; //kHz
fRFl=905; //kHz



fIF=fio-fRF;

disp('kHz',fIF,"fIF = ");

disp("The upper and lower intermediate are");

fIFu=fio-fRFu;

disp('kHz',fIFu,"fIF = ");

fIFl=fio-fRFl;

disp('kHz',fIFl,"fIF = ");
```

**Scilab code Exa 5.5** Determine 1 image frequency 2 image frequency rejection ratio for a Q of 120 for the tuned circuit in the preselector of the receiver 3 IFRR if the preselector of 2 is followed by another RF tuned of IFR

```
clc;
```

```
//Example 5.5
//Page no 172




//solution

Fl=1255; //kHz
Fif=455; //kHz
FRF=800; //kHz
Q=120;

//(a)

Fim=Fl+Fif;

disp('kHz',Fim,"(a)Image Frequency Fim = ");


//(b)

p=((Fim/FRF)-(FRF/Fim));

IFRR=sqrt(1+(Q^2)*(p^2));

disp(IFRR,"(b)IFRR = ");

//(c)

IFRR1=5.6;

IFRRt=IFRR*IFRR1;

disp(IFRRt,"(c)Combined IFRR of both the circuits =
   ");
```

**Scilab code Exa 5.6** Determine 1 local oscillator frequency 2 image frequency 3 IFRR for a preselector Q of 160 4 preselector Q required to achieve the IFRR as that achieved for an RF carrier of 600kHz

```
clc;
//Example 5.6
//Page no 172


//Solution

FRF=27000; //MHz
Fif=455; //kHz
Q=100;

//(a)

disp("(a)From equation 5-7(refer pgno 165)");

flo=FRF+Fif;

Flo=(flo/(10^3));

disp('MHz',Flo,"Flo = ");

//(b)

disp("(b)From equation 5-9 (refer pgno 171) ");

fim=flo+Fif;

Fim=(fim/(10^3));

disp('MHz',Fim,"Flo = ");
```

```
//(c)

disp("(c)From equation 5-11 (refer pgno 171)");

p=((fim/FRF)-(FRF/fim));

IFRR=sqrt(1+(Q^2)*(p^2));

disp(IFRR,"IFRR = ");

//(d)

fr=600

fim1=fr+2*Fif;

p1=((fim1/fr)-(fr/fim1));

disp("(d)Rearranging equation 5-11 ");

q=sqrt(((IFRR^2)-1)/(p1^2));

disp(q,"Q = ");
```

**Scilab code Exa 5.7** Calculate 2 IFRR 2 IFRR in dB 3 IFRR for an IF of 455kHz 4 Q of primary and secondary circuit of the IF transformer is 40 and 50 so find critcal coupling factor

```
clc;
//Example 5.7
//Page no 184


//solution
```

```
Fs=100; //MHz
Fif=10.7; //MHz
Q=100;
Q1=40;
Q2=50;


//(a)

disp("(a)");

flo=Fif+Fs;

Fim=Fs+2*Fif;

disp('MHz',Fim,"Fimage = ");

p=((Fim/Fs)-(Fs/Fim));

disp(p,"p = ");

IFRR=sqrt(1+(Q^2)*(p^2));

disp(IFRR,"IFRR = ");

//(b)

disp("(b)");

ifrr=20*log10(IFRR);

disp('dB',ifrr,"IFRR in dB = ");

//(c)

disp("(c)");

```

```
fif=(455/(10^3));

fim=Fs+2*fif;

disp('MHZ',fim,"Fimage = ");

p1=((fim/Fs)-(Fs/fim));

disp(p1,"p = ");

IFRR1=sqrt(1+(Q^2)*(p1^2));

disp(IFRR1,"IFRR = ");

//(d)

disp("(d)Critical coupling factor of the primary and secondary circuit if IF transformer,");

kc=(sqrt(Q1*Q2))^-1;

disp(kc,"Kc = ");
```

**Scilab code Exa 5.8** Determine the net receiver gain and the audio signal level

```
clc;
//Example 5.8
//Page no 198




//solution

```

```
A=-80; //dB
G1=33; //dB
G2=47; //dB
G3=25; //dB

G=G1+G2+G3;

disp('dB',G,"The sum of the gains is, ");

L1=3; //dB
L2=6; //dB
L3=8; //dB

L=L1+L2+L3;

disp('dB',L,"The sum of the losses is, ");

G4=G-L;

disp('dB',G4,"Thus, net receiver gains is, ");

B=A+G4;

disp('dBm',B,"and the audio signal level is, ");
```

# Chapter 6

# Single Sideband Communication Systems

**Scilab code Exa 6.1** Determine the quality factor necessary for a single sideband filter with a 1MHz carrier frequency 80dB unwanted sideband suppression and the following frequency spectrum

```
clc;
//Example 6.1
//Page no 224

//solution

f=1000; //kHz
s=80;
df=200; //khz

disp("Substituting into Equation 6-3 (refer pgno
   223)");

Q=125000;

disp(Q,"Q = ");
```

**Scilab code Exa 6.2** Determine demodulated first IF frequency band and demodulated information frequency band and demodulated information frequency band if the RF local oscillator frequency drift

```
clc;
//Example 6.2
//Page no 230


//solution

f0=30; //MHz
f1=30.005 //MHz
flo=20; //MHz
fbfo=10; //MHz
d=(0.001/100); //%

//(a)


disp("(a)The IF output from the RF mixer difference
   between the received signal frequency and the RF
   local oscillator frequency,");

fu=f0-flo;
fl=f1-flo;

disp('MHz',fl,"MHz to",fu,"Fif = ");


fm1=fu-fbfo;
fm2=fl-fbfo;

disp('kHz',(fm2*(10^3)),"kHz to",fm1,"fm = ");
```

```

//(b)

disp("(b)A 0.001% drift would cause a decrease in
    the RF local oscillator frequency of ");

df=d*flo;

disp('Hz',(df*(10^6)),"df = ");


fl=(flo-df);
fi=f0-fl;
ff=f1-fl;

disp('MHz',ff,"MHz to",fi,"Fif = ");


fm3=fi-fbfo;
fm4=ff-fbfo;

disp('Hz',(fm4*(10^6)),"Hz to",(fm3*(10^6)),"fm = ")
    ;
```

**Scilab code Exa 6.3** Determine the demodulated first IF frequency band and demodulated information frequency band and demodulated information frequency band

```
clc;
//Example 6.3
//Page no 231



//Solution
```

```
fbfo=10; //MHz

//(a)

disp("(a)The solution is identical to that provieded in example 6−2 ");

Fi=30-20; //MHz
Ff=30.005-20; //MHz

disp('MHz',Ff,"MHz to",Fi,"Fif = ");

disp("The demodulated information signal spectrum is simply the difference between the intermediate frequency band and the BFO frequency");

fm1=Fi-fbfo;
fm2=Ff-fbfo;

disp('kHz',(fm2*(10^3)),"kHz to",fm1,"fm = ");

//(b)

disp("(b) ");

FI=30.0006-20.0004; //MHz
FF=30.0056-20.0004; //MHZ

disp('MHz',FF,"MHz to",FI,"Fif = ");

disp("The BFO frequency will also automatically adjust proportionally to 10.0002MHz, producing a demodulated information signal of ");

Fm=FI-10.0002; //MHz
Fm1=FF-10.0002; //MHz

```

```
disp('kHz',(Fm1*(10^3)),"kHz to",Fm,"fm = ");
```

**Scilab code Exa 6.4** Determine for a single sideband suppressed carrier transmission the output frequency spectrum and a load resistance and the PEP and average power

```
clc;
//Example 6.4
//Page no 238



//solution

Frf=100; //kHz
fs1=1.5; //kHz
fs2=3; //kHz
R=50; //Ohm
E=5; //V

//(a)

disp("(a)The output frequency specctrum contains the two upper side frequencies: ");

Fusf1=Frf+fs1;
Fusf2=Frf+fs2;

disp('kHz',Fusf2," Fusf2 = ",'kHz',Fusf1," Fusf1 = ");

//(b)

disp("(b)Substituting in equation 6-6 yields, ");

PEP=([2*(0.707*E)^2]/R);
```

```
disp('W',PEP,"PEP = ")

disp("Substituting into equation 6-8 yields, ");

Pavg=(PEP/2);

disp('W',Pavg,"Pavg = ");
```

# Chapter 7

# Angle Modulation Transmission

**Scilab code Exa 7.1** Determine 1 the peak frequency deviation and modulation index for an FM modulator 2 the peak phase deviation for a PM modulation

```
clc;
//Example 7.1
//Page No 253


//Solution

//(a)

K1=5; //kHz/V
Ap=2; //V
k1=2.5; //rad/V
fm=2; //kHz

disp("(a)The peak frequency deviation is simply the
    product of the deviation sensitivity and the peak
     amplitude of the modulation signal, ");

df=K1*Ap;
```

```
disp('kHz',df,"df = ");

disp("The modulation index is determined by substituting into equation 7-22(r)");

m=df/fm;

disp(m,"m = ");

//(b)

disp("The peak phase shift for a phase-modulation wave is the modulation index and is found by substituting into equation 7-15(refer pgno 250)");

m1=k1*Ap;

disp('rad',m1,"m = ");
```

**Scilab code Exa 7.2** Determine 1 carrier frequency 2 modulation frequency 3 modulation index 4 peak phase deviation

```
clc;
//Example 7.2
//Page No 253


//Solution

wc=(6.28*10^6);
wm=(6.283*10^3);

disp("   Vpm(t)=A sin(wct + mp sin wmt) ","The
```

```
    mathematical expression for a phase-modulated
    wave is given as, ");

fc=wc/(2*%pi);

disp('MHz',round(fc/10^6),"(a)Carrier Frequency
                    fc = ");

fm=wm/(2*%pi);

disp('kHz',round(fm/10^3),"(b)Modulating Frequency
                  fm = ");

disp(10,"(c)Modulating index              mp = ");

disp('rad',10,"(d)Peak phase deviation
    d0 = ");
```

**Scilab code Exa 7.3** Determine 1 Number of sets of significant side frequenices 2 Amplitude of the frequencies 3 Draw the spectrum

```
clc;
//Example 7.3
//Page No 257

disp("Given: An FM modulator with a modulation index
     m=1, a modulating signal v,(t)=Vmsin(2pi1000t)
    and an unmodulated carrier vc(t)=10sin(2pi500kt).
    ");

//Solution

//(a)

disp("(a)From Table 7.3, a modulation index of 1
```

```
    yields a reduced carrier component and three sets
     of significant side frequencies. ");

//(b)

disp("(b)The relative amplitudes of the carrier and
    side frequencies are, ");

disp("                        J0= 0.77x(10) = 7.7 V");

disp("                        J1= 0.44x(10) = 4.4 V");

disp("                        J2= 0.11x(10) = 1.1 V");

disp("                        J3= 0.02x(10) = 0.2 V");

disp("(c)The frequency spectrum is shown in figure
    7-6.");
```

**Scilab code Exa 7.4** Determine 1 actual minimum bandwidth from the Bessel function table 2 approximate minimum bandwidth using Carsons rule 3 plot the output frequency spectrum for the Bessel approximation

```
clc;
//Example 7.4
//Page No 259

disp("Given:  An FM modulator with a peak frequency
    deviation df=10kHz, a modulating signal frequency
     fm=10kHz, Vc=10V and a 500kHz carrier. ");

//Solution

df=10;

```

```
fm=10;

n=3;

//(a)

disp("(a)Substituting into equation 7-22(refer pgno 251) ");

m=df/fm;

disp(m,"m = ");

disp("From Table 7.3")

B=2*(n*fm);

disp('kHz',B,"B = ");

//(b)

disp("(b)Substitttuting into equation 7-34(refer pgno 259), the bandwidth is  ");

b=2*(df+fm);

disp('kHz',b,"B = ");

//(c)

disp("(c)The relative amplitudes of the carrier and side frequencies are, ");

disp("                              J0= 0.77x(10) = 7.7 V");

disp("                              J1= 0.44x(10) = 4.4 V");

disp("                              J2= 0.11x(10) = 1.1 V");
```

```
disp("                    J3= 0.02x(10) = 0.2 V");

disp("The output frequency spectrum for the Bessel approximation is shown in figure 7-7.");
```

**Scilab code Exa 7.5** Determine the deviation ratio and bandwidth for 1 the worst case modulation index 2 an equal modulation index

```
clc;
//Example 7.5
//Page No 260



//Solution

df=75;

fm=15;

//(a)

disp("(a)The deviation ratio is found by substituting into equation 7-35(refer pgno), ");

DR=df/fm;

disp(DR,"DR = ");

disp("From Table 7.3");

B=2*(8*fm);

disp('kHz',B,"B = ");
```

```
//(b)

disp("(b)For an 37.5kHz frequency deviation and
   modulating signal frequency fm=7.5, the
   modulation index is, ");

m=37.5/7.5;

disp(m,"m = ");

disp("and the bandwidth is, ");

b=2*(8*7.5);

disp('kHz',b,"B = ");
```

**Scilab code Exa 7.6** Determine 1 the modulation indexes and sketch the output spectrum 2 change the modulating signal amplitude to 4Vp for 1 3 change the modulating signal frequency to 1kHz for 1

```
clc;
//Example 7.6
//Page No 261



//solution

K=0.75;
fcp=500;
K1=1.5;
fcf=500;
vm=2;
fm=2;
```

```
Vm=4;
Fm=1;

//(a)

disp("(a) FM Modulator ");

m=(vm*K1)/fm;

disp(m,"m = ");

disp("PM Modulator ");

m1=vm*K;

disp(m1,"m = ");

disp("Since the modulation indexes are same the output spectrum is also the same, which is in figure 7-8(a) ");

//(b)

disp("(b) FM Modulator ");

M=(Vm*K1)/fm;

disp(M,"m = ");

disp("PM Modulator ");

M1=Vm*K;

disp(M1,"m = ");

disp("Again, since the modulation indexes are same the output spectrum is also the same, which is in figure 7-8(b) ");
```

```
//(c)

disp("(a) FM Modulator ");

m2=(vm*K1)/Fm;

disp(m2,"m = ");

disp("PM Modulator ");

m3=vm*K;

disp(m3,"m = ");

disp("Since the modulation indexes are not same the
    output spectrum are given in figures 7-8(c) and
    7-8(d), respectively");
```

**Scilab code Exa 7.7** Determine 1 the unmodulated carrier power for the FM modulator 2 the total power in the angle modulated wave

```
clc;
//Example 7.7
//Page No 265

disp("Given: Conditions as per example 7-3 and
    assume a load resistance Rl=50");

//solution

Rl=50;
Vc=10;
vc=7.7;
V1= 4.4;
```

```
V2= 1.1;
V3= 0.2;

//(a)

disp("(a)Substituting into equation 7-36 yields, ");

Pc=(Vc^2)/(2*Rl);

disp('W',Pc,"Pc = ")

//(b)

disp("(b)Substituting into equation 7-41 yields, ");

Pt=((vc^2)/(2*Rl)+(V1^2)*2/(2*Rl)+(V2^2)*2/(2*Rl)+(V3^2)*2/(2*Rl));

disp('W',Pt,"Pt = ");
```

**Scilab code Exa 7.8** Determine 1 frequency of the demodulated interference signal 2 peak phase and frequency deviations due to the interfering signal 3 voltage signal to noise ratio at the output of the demodulator

```
clc;
//Example 7.8
//Page No 268



//solution

fc=110;
fn=109.985;
Vn=0.3;
```

```
Vc=6;
fd=75*(10^3);

//(a)

disp("(a)The frequency of the noise interference is the difference between the carrier frequency and the frequency of the single frequency interfering signal, ");

n=fc-fn;

disp('kHz',(n*10^3),"NI = ");

//(b)

disp("(b)substituting into equation 7-43 yields, ");

t=Vn/Vc;

disp('rad',t,"dt = ");

disp("substituting into equation 7-47 yields, ");

df=(Vn*n)/Vc;

disp('Hz',(df*10^6),"df = ");

//(c)

a=Vc/Vn;

disp(a,"(c)The voltage S/N ");

disp("The voltage S/N ratio after demodulation is found by substituting into equation 7-49");

sn=fd/(df*10^6);
```

```

disp(sn,"S/N = ");

ip=20*log10(100/20);
;
disp('dB',round(ip),"Thus, there is an signal to
   noise improvement of ")
```

**Scilab code Exa 7.11** Determine 1 master oscillator centre frequency 2 frequency deviation at output for a frequency deviation of 75kHz at antenna 3 deviation ratio for fm 4 deviation ratio of antenna

```
clc;
//Example 7.11
//Page No 283


//solution

N=20;
ft=88.8;
dF=75;
fm=15;

//(a)

fc=ft/N;

disp('MHz',fc,"(a)fc = ");

//(b)

df=dF/20;

disp('Hz',(df*10^3),"(b)df = ");
```

```
//(c)

dr=df/fm;

disp(dr,"(d)DR = ");

//(d)

DR=dr*N;

disp(DR,"(b)DR = ");
```

# Chapter 8

# Angle Modulation Reception and FM Stereo

**Scilab code Exa 8.1** Determine the peak output voltage

```
clc;
//Example 8.1
//Page no 298


//Solution

Kd=0.2; //V/kHz
df=20; //kHz

disp("Substituting into equation 8-2, the peak
   output voltage is ")

Vo=Kd*df;

disp('Vp',Vo,"vout(t) = ")
```

**Scilab code Exa 8.2** Determin the minimum receive carrier power necessary to achieve a postdetection signal to noise ratio 37dB

```
clc;
//Example 8.2
//Page no 309



//Solution

B=200*(10^3); //kHz
NF=8; //dB
T=100; //K
m=1;

a=37-17; //dB

disp('dB',a," the prediction signal to noise ratio
   must be atleast , ");

b=20+8; //dB

disp('dB',b,"Therefore, for an overall receiver
   noise figure equal to 8dB, the S/N ratio at the
   input to the receiver must be atleast , ");

disp("The receiver input noise power is , ");

K=(1.38*(10^-23));

N=10*log10((K*T*B)/0.001);

disp('dBm',N,"N(dB) = ");

disp("Consequently, the minimum receiver signal
   power for a 28dB S/N ratio is , ");

```

```
S=N+28;

disp('dBm',S,"S = ");
```

**Scilab code Exa 8.3** Determine the pre and postdetection SN ratios

```
clc;
//Example 8.3
//Page No 309



//Solution

SN=29; //dB
NF=4; //dB
FMi=16; //dB

disp("The predetection signal to noise ratio is ");

pre=SN-NF;

disp('dB',pre,"S/N(pre) = ");

disp("The postdetection signal to noise ratio is ");

pst=pre+FMi;

disp('dB',pst,"S/N(post) = ");
```

**Scilab code Exa 8.4** Determine the minimum receive signal level

```
clc;
```

```
//Example 8.4
//Page no 310



//solution

SN=38; //dB
In=-112; //dBm
FMi=17; //dB
NF=5; //dB

sn=SN-FMi+NF;

disp('dB',sn,"The receiver input S/N is ");

rs=In+sn;

disp('dBm',rs,"Therefore, the minimum receive signal
    level is ");
```

# Chapter 9

# Digital Modulation

**Scilab code Exa 9.2** Determine the peak frequency deviation minimum bandwidth baud rate for a binary FSK signal

```
clc;
//Example 9.2
//Page no 339

//solution

fm=49;
fs=51;
fb=2; //nyquist rate


//(a)
disp("(a)The peak frequency deviation is determine
   from equation 9-14(refer pgno 338)");

df=(fs-fm)/2;

disp('kHz',df,"df = ");

//(b)
```

```
disp("(b)The minimum bandwidth is determined from
    equation 9-15(refer pgno 339)");

B=2*(df+fb);

disp('kHz',B,"B = ");

//(c)

disp("(c)For FSK, N=1 and the baud rate is
    determined from equation 9-11 as ");

n=1;

baud=fb*10^3/n;

disp(baud,"baud = ");
```

**Scilab code Exa 9.3** Determine the minimum bandwidth for the FSK signal

```
clc;
//Example 9.3
//Page no 340



//solution

fm=49;
fs=51;
fb=2;

disp("The modulation index is determine from
```

```
equation 9-17(refer pgno 340)");

h=(fs-fm)/2;

disp(h,"h = ");

disp("From Bessel table, the bandwidth can be determine as follows, ");

b=2*(3*h);

disp('hz',b*10^3,"B = ");
```

**Scilab code Exa 9.15** Determine the minimum bandwidth required

```
clc;
//Example 9.15
//Page No 382


//solution

ebn0=14.7;
cn=11.7;
fb=10;

disp("From Figure 9-48,");

bfb=ebn0-cn;

Bfb=exp(log10(bfb));

disp('dB',round(Bfb),"B/fb = ");

B=2*fb;
```

```
disp('MHz',B,'B = ');
```

# Chapter 10

# Digital Transmission

**Scilab code Exa 10.1** Determine the largest value capacitor that can be used in figure

```
clc;
//Example 10.1
//Page No 395



//Solution

i=10*10^-4;
dt=10*10^-9;
dv=10;

disp("The expression for the current through a
    capacitor is ");

disp("i = C dv/dt");

disp("Rearranging and solving for c yields, ");

c=i*dt/dv;
```

```
disp('F',c,"C = ");

disp("t = RC","The charge time constant for C when
   Q1 in on is ");

disp("Therefore, rearranging the above equation and
   substituting the value of chaging time yields");

C=dt/(4.6*20);

disp('F',C/100,"C = ");
```

**Scilab code Exa 10.3** Determine the quantized voltage quantization error and PCM code

```
clc;
//Example 10.3
//Page No 400

disp("Given: For figure, Analog sample voltage of
   +1.07 V. ;");

//solution



a=1.07/1

disp(round(a));

disp("The quantization error is the difference
   between the original sample voltage and the
   quantized level, or");

```

```
q=1.07-1;

disp(q,"Qe = ");

disp("From Table 10-2, the PCM code for 1 is 101");
```

**Scilab code Exa 10.4** Calculate 1 the resolution and quantization error 2 the coding efficiency for a resolution

```
clc;
//Example 10.4
//Page No 403

disp("Given: For minimum line speed with an 8-bit PCM for speech signal ranging upto 1 V. ");

//solution

v=1;
n=8;


disp("Minimum line speed with an 8-bit PCM is 64Kbps.");

//(a)

r=v/(2^n-1);

disp('V',r,"(a)Resolution = ");

q=r;

disp('V',q,"Therefore, Resolution = quantization, q=");
```

```
qe=q/2;

disp('V',qe,"Quantization error = ");

//(b)

disp("(b)Dynamic range DR for 0.001 V resolution ");

dr=20*log10(v/0.01);

disp('db',dr,"DR = ");

disp("Minimum number of bits n required to achieve the dynamic range is given by ");

N=((log(100+1))/(log(2)));

disp(N,"n = ");

c=(N/n)*100;

disp('%',c,"Therefore, coding efficiency = ");
```

**Scilab code Exa 10.8** Determine the minimum line speed in bits per second to transmit speech signal of 1 a 7 bit PCM 2 an 8 bit PCM

```
clc;
//Example 10.8
//Page No 418

//solution
```

```
s=8;

//(a)

disp("(a)With the 7 bit PCM,");

b=7;

r=s*b;

disp('kbps',r,"line speed = ");

//(b)

disp("(b)With the 8 bit PCM, ");

b1=8;

r1=s*b1;

disp('kbps',r1,"line speed = ");
```

# Chapter 12

# Metallic Cable Transmission Media

**Scilab code Exa 12.1** Determine the characteristic impedance for an air dielectric two wire parallel transmission line

```
clc;
//Example 12.1
//Page No 505

disp("Given: A D/r ratio of 12.22");

//solution

dr=12.22;

disp("Susbstituting into equation 12-14(refer pgno
   505), we obtain ");

Z0=276*log10(dr);

disp('Ohm',round(Z0),"Z0 = ");
```

**Scilab code Exa 12.2** Determine the characteristic impedence for coaxial cable

```
clc;
//Example 12.2
//Page No 506


//Solution

d=0.025;
D=0.15;
e=2.23;

disp("Substituting into Equation 12-15(refer pgno506
   ) give us, ");

Z0=-((138/sqrt(e))*(log10(d/D)));

disp('Ohms',Z0,"Z0 = ");
```

**Scilab code Exa 12.3** Charecteristic impedence for RG-59A coaxial cable

```
clc;
//Example 12.3
//Page No 506

disp("Given: An RG-59A coaxial cable, with L=0.118uH
   /ft and C=21pF/ft");

//Solution

```

```
L=0.118*10^-6;
C=21*10^-12;

disp("Substituting into Equation 12-15(refer pgno506) give us,");

Z0=sqrt((L/C));

disp('ohm',round(Z0),"Z0 = ");
```

**Scilab code Exa 12.4** Determine the velocity of propagation and the velocity factor

```
clc;
//Example 12.4
//Page No 509



//solution

C=96.6*10^-12;
L=241.56*10^-9;
ep=2.3;
c=3*10^8;

disp("From equation 12-16 ");

Vp=(1/sqrt(C*L));

disp('m/s',Vp,"Vp = ");

disp("From equation 12-24 ");

Vf=(Vp/c);
```

```
disp(Vf,"Vf = ");

disp("From equation 12-26 ");

vf=(1/sqrt(ep));

disp(vf,"Vf = ");
```

**Scilab code Exa 12.5** Determine reflection coefficient and SWR

```
clc;
//Example 12.5
//Page No 514


//solution

Ei=5;
Er=3;

disp("Substituting into equation 12-33 yield");

r=Er/Ei;

disp(r,"r = ");

disp("Substituting into equation 12-37 yield");

swr=(Ei+Er)/(Ei-Er);

disp(swr,"SWR = ");

disp("Substituting into equation 12-45 yield");

```

```
r1=(swr-1)/(swr+1);

disp(r1,"r = ");
```

**Scilab code Exa 12.6** Determine the physical length and characterictic impedence for a quarter wavelength transformer

```
clc;
//Example 12.6
//Page No 524


//solution

f=150*10^6;
c=3*10^8;
z0=50;
zl=150;

disp("The Physical length of the transformer depends
    on the wavelength of the signal. Substituting
   into equation 12-3 yields, ");

l=(c/f);

disp('m',l,'l = ');

l=l/4;

disp('m',l,'l = ');

disp("The characteristic impedance of the 0.5m
   transformer is determined from the equation 12-47
    ");

```

```
Z0=sqrt(z0*zl);

disp('Ohm',Z0,"Z0 = ")
```

**Scilab code Exa 12.7** How far down the cable is the impairment

```
clc;
//Example 12.7
//Page No 526



//Solution

c=3*10^8;

disp("Substituting into equation 12-48");

d=((0.8)*c*(1*10^-6))/2;

disp('m',d,'d = ');
```

**Scilab code Exa 12.8** Determine the time elapsed from the beginning of the pulse to the reception of the echo

```
clc;
//Example 12.8
//Page No 527



//solution

```

```
c=3*10^8;
d=3000;
k=0.9;

disp("Rearranging Equation 12-48 ");

t=((2*d)/(k*c));

disp('s',t,"t = ")
```

# Chapter 13

# Optical Fiber Transmission Media

**Scilab code Exa 13.1** Determine the angle of refraction

```
clc;
//Example 13.1
//Page No 545



//solution

n1=1.5;
n2=1.36;
t1=30;

disp("From Table, ")

disp(n1,"n1(glass) = ");

disp(n2,"n2(alcohol) = ");

disp("Rearranging equation 13-9 and substituting, we
```

```
get ");

t=((n1/n2)*sin(%pi/6));

disp(t,"t2 = ");

t3=asin(t);

t2=t3*(180/%pi);

disp(t2,"t2 = ");
```

**Scilab code Exa 13.2** Calculate the refractive index of the cladding

```
clc;
//Example 13.2
//Page No 554



//solution

n1=1.485;
a=50*10^-6;
N=320;
l=0.850*10^-6;

disp("Number of modes in a step-index fibre , N is given by equation 13-13, ");

r=(sqrt(320)*((l)/(%pi*2*a)));

n2=n1-r;

disp(n2,"n2 = ");
```

**Scilab code Exa 13.3** Calculated the optical power

```
clc;
//Example 13.3
//Page No



//solution

al=0.25*100;
Pt=1*10^-4;

disp("Substituting in equation 13-15, ");

p=Pt*(10^(al/10));

disp('uW',p*10,"P = ");

P=10*log10(p*10^-5/0.001);

disp('uW',P,"P(dB) = ");
```

**Scilab code Exa 13.4** Calculate the maximum data rate through a 6 km long step index fibre

```
clc;
//Example 13.4
//Page No 558


```

```
//solution

n1=1.48;
n2=1.46;
L=6000;

d=((n1-n2)/n1);

disp(d,"d = ");

t=((d*L)/(3*10^8));

T=0.03996;

disp('ns',T,"Intermodal delay t = ");

disp("Therefore, the maximum data rate Fmax is given
    by, ");

F=(1/(2*T));

disp('MHz',F,"Fmax = ");
```

**Scilab code Exa 13.5** Determine the maximum digital transmission rates for return to zero and nonreturn to zero

```
clc;
//Example 13.5
//Page No 561


//solution

L=10000;
dt=5*10^-6;
```

```
disp("Substituting into equation 13-18 yields ");

fb=(1/(dt*L));

disp('Mbps',fb,"fb = ");

disp("Substituting into equation 13-19 yields ");

Fb=(1/((2*dt)*L));

disp('Mbps',Fb,"fb = ");
```

**Scilab code Exa 13.6** Determine th optical power received in dBm and watts

```
clc;
//Example 13.8
//Page No 575



//solution

P=30*10^-3;
cl=0.5;
conl=2;
ltc=1.9;
ctd=2.1;



disp("The LED output power is converted to dBm using
    equation 13-6");

```

```
Po=10*log10(P/0.001);

disp('dBm',Po,"Po = ");



t=20*cl;

disp('dB',t,"total cable loss = ");



c=3*conl;

disp('dB',c,"total connector loss = ");

//light source to cable and cable to light detector
   losses

tl=t+c+ltc+ctd;

disp('dB',tl,"total loss = ");

disp("The receive power is determined by
   substituting into equation 13-22 ");

Pr=Po-tl;

disp('dBm',Pr,"Pr = ");
```

# Chapter 14

# Electromagnetic Wave Propagation

**Scilab code Exa 14.1** Determine power density from source at 1000m and 2000m

```
clc;
//Example 14.1
//Page No. 584



//Solution

Prad=100;
r1=1000;
r2=2000;

//(a)

disp("(a)Substituting into equation 14-7 yields, ");

p1=((Prad)/(4*%pi*(r1^2)));

```

```
disp('uW/m^2',p1*10^6,"P1 = ");

//(b)

disp("(b)Substituting into equation 14-7 yields, ");

p2=((Prad)/(4*%pi*(r2^2)));

disp('uW/m^2',p2*10^6,"P2 = ");
```

**Scilab code Exa 14.2** Determine the height of the receiving antenna and the maximum transmission distance

```
clc;
//Example 14.2
//Page No 597



//Solution

//(a)

d=48.7;
ht=40;

disp("(a)As per equation 14-23, ");

hr=(((d-sqrt(17*ht))^2)/17);

hr=round(hr);

disp('m',hr,"hr = ");

//(b)
```

```
Ht=2*ht;
Hr=2*hr;

D=((sqrt(17*Ht))+(sqrt(17*Hr)));

disp('km',D,"(b)Dmax = ");
```

**Scilab code Exa 14.3** Determine the fade margin

```
clc;
//Example 14.3
//Page No 603

//Solution

D=40;
f=1.8;
o=0.9999;

disp("Substituting into equation 14-34, ");

Fm=([30*log10(D)]+[10*log10([6*4*0.5*f])]-[10*log10
    (1-o)]-70);

disp('dB',Fm,"Fm = ")
```

# Chapter 15

# Antennas and Waveguides

**Scilab code Exa 15.1** Determine antenna efficiency antenna gain radiated power in watts dBm dBW and EIRP in watts dBm dBW

```
clc;
//Example 15.1
//Page No 616



//solution

Rr=72;
Re=8;
D=20;
Pin=100;

//(a)

disp("(a)Antenna efficiency is found by substituting
    into equation 15-3 ");

n=(Rr/[Rr+Re])*100;

```

```
disp('%',n,"n = ");

//(b)

disp("(b)Antenna gain ");

A=(n/100)*(D);

disp('and','dB',A,"A = ");

A1=10*log10(A);

disp('dB',A1,"A = ");

//(c)

disp("(c)Radiated power");

Prad=(n/100)*Pin;

disp('W',Prad,"Prad = ");

prad=10*log10(Prad/0.001);

disp('dBm',prad,"Prad(dBm) = ");

pRad=10*log10(Prad);

disp('dBW',pRad,"Prad(dBW) = ");

//(c)

disp("(d)EIRP is found by substituting into
    equations 15-7d,e and f");

EIRP=Pin*A;

disp('W',EIRP,"EIRP = ");
```

```
EIRP1=10*log10(EIRP/0.001);

disp('dBm',EIRP1,"EIRP(dBm) = ");

EIRP2=10*log10(EIRP)

disp('dBW',EIRP2,"EIRP(dBW) = ");
```

**Scilab code Exa 15.2** Determine the antenna input radiated power EIRP and receive power density

```
clc;
//Example 15.2
//Page No 616



//solution

Dt1=1;
Dt2=10;
n1=1;
n2=0.5;
At=5;
Lp=50;
Lf=3;
Pout=40;

//(a)

disp("(a)The antenna input power in dBm is ")

Pin=Pout-Lf;

```

```
disp('dBm',Pin,"Pin = ");

disp("Radiated power in dBm is ");

N1=10*log10(n1);

Prad=Pin+N1;

disp('dBm',Prad,"Prad = ");

At1=Dt1*n1;

EIRP1=Prad+(10*log10(At1));

disp('dBm',EIRP1,"EIRP = ");

P1=EIRP1-Lp;

disp('dBm',P1,"P = ");

//(b)

disp("(b)The antenna input power in dBm is ")

Pin=Pout-Lf;

disp('dBm',Pin,"Pin = ");

disp("Radiated power in dBm is ");

N2=10*log10(n2);

Prad=Pin+N2;

disp('dBm',round(Prad),"Prad = ");

EIRP2=Prad+(10*log10(Dt2));

```

```
disp('dBm',round(EIRP2),"EIRP = ");

P2=EIRP2-Lp;

disp('dBm',round(P2),"P = ");

//(c)

disp("(c)The antenna input power in dBm is ")

Pin=Pout-Lf;

disp('dBm',Pin,"Pin = ");

disp("Radiated power in dBm is ");

N3=10*log10(n2);

Prad=Pin+N3;

disp('dBm',round(Prad),"Prad = ");

EIRP3=Prad+(10*log10(At));

disp('dBm',round(EIRP3),"EIRP = ");

P3=EIRP3-Lp;

disp('dBm',round(P3),"P = ");
```

**Scilab code Exa 15.3** Determine captured power in dBm and watts

```
clc;
//Example 15.3
//Page No620
```

```
//solution

P=10;
Ac=0.2;

disp("Substituting into equation 15-12 yields ");

Pcap=P*Ac;

disp('uW',Pcap,"Pcap = ");

pcap=10*log10(Pcap*10^-6/0.001);

disp('dBm',round(pcap),"Pcap(dBm)");
```

**Scilab code Exa 15.4** Determine beamwidth transmit and receive power gain and EIRP

```
clc;
//Example 15.4
//Page No 643


//solution

D=2;
c=3*10^8;
f=6;
Pt=10;

disp("(a)The beam width is found by substituting
    into equation 15-29 ");

```

```
O=([70*c]/[(f*10^9)*D]);

disp(O,"T = ");

disp("(b)The transmit power gain is found by substituting into equation 15-31c, ");

A=([20*log10(f*10^3)]+[20*log10(2)]-42.2);

disp('dB',A,"Ap(dB) = ");

disp("(c)The receive power gain is found by substituting into equation 15-33c, ");

l=(c/(f*10^9));

disp('m/cycle',l,"l = ");

Ap=10*log10(5.4*[(D/l)^2]);

disp('dB',Ap,"Ap(dB) = ");

disp("(d)The EIRP is the product of the radiated power times the transmit antenna gain, ");

EIRP=Ap+(10*log10(Pt/0.001));

disp('dB',EIRP,"EIRP = ");
```

**Scilab code Exa 15.5** Determine Cutoff frequency and wavelength group and phase velocity

```
clc;
//Example 15.5
//Page No 651
```

```
//solution

f=6;
a=0.03;
c=3*10^8;

disp("(a)The cutoff frequency is determined by
   substituting into equation 15-41, ");

fc=(c/(2*a));

fc=fc/10^9;

disp('GHz',fc,"fc = ");

disp("(b)The cutoff wavelength is determined by
   substituting into equation 15-42, ");

lc=2*(a);

disp('m',lc,"lc = ")

disp("(c)The phase velocity is found using equation
   15-41, ");

vph=(c/[sqrt(1-({fc/f}^2))]);

disp('m/s',vph,"vph = ");

disp("(d)The group velocity is found by rearranging
   equation 15-36, ");

vg=([c^2]/vph);

disp('m/s',vg,"vg = ");
```

**Scilab code Exa 15.6** Determine the cutoff frequency and the characteristic of TE10

```
clc;
//Example 15.6
//Page No 652


//solution

a=9;
b=4.5;
f=4;
c=3*10^10;

disp("(a)Cutoff frequency, ");

fc=(c/(2*a));

fc=fc/10^9;

disp('GHz',fc,"fc = ");

disp("(b)Characteristic impedence, ");

Zte=(377/[sqrt(1-({fc/f}^2))]);

disp('ohm',Zte,"Zte = ");
```

# Chapter 17

# The Telephone Circuit

**Scilab code Exa 17.1** Determine the power level in dBm and the difference between them

```
clc;
//Example 17.1
//Page No 690



//solution

p1=10*10^-3;
p2=0.5*10^-3;

disp("(a)The power levels, ");

P1=10*log10(p1/0.001);

disp('dBm',P1,"P = ");

P2=10*log10(p2/0.001)

disp('dBm',round(P2),"P = ");
```

```
disp("(b)The difference  ");

P=10*log10(p1/p2);

disp('dBm',round(P),"diff = ");

disp("The 10mW power level is 13dB higher than 0.5W
   power level. ");
```

# Chapter 19

# Cellular Telephone Concepts

**Scilab code Exa 19.1** Determine the number of channels per cluster and total channel capacity

```
clc;
//Example 19.1
//Page No 749

//solution

disp("The total number of full-duplex channels is, "
  );

F=10*7

disp("channel per cluster",F,"F = ");

disp("The total channel capacity is,")

C=10*7*10;

disp("channel total",C,"C = ");
```

**Scilab code Exa 19.2** Determine for a cell area

```
clc;
//Example 19.2
//Page No 752


//solution

Asys=1520;
Acell=4;
n=1140;
j=2;
i=3;

//(a)

disp("(a)Number of cells in a cluster, N ");

N=(i^2)+(i*j)+(j^2);

disp(N,"N = ");

//(b)

disp("(b)Number of clusters in the systems = area of
    the system / area of each cluster");

ac=N*Acell;

N1=(Asys/ac);

disp(N1,"Number of clusters = ");

```

```
//(c)

disp('Km^2',ac,"(c)Area of each celler cluster  = ")
    ;

//(d)

sc=N1*n;

disp('channels',sc,"(d)System capacity with
    frequency reuse = number of cluster X number of
    channels without frequency reuse, i.e.");

//(e)

disp("(e)Number of channels allocated to each cell,
    ");

c=(Asys/Acell);

disp(c,"(i)without frequency reuse = ");

C=(n/N);

disp(C,"(ii)With frequency reuse = ");
```

**Scilab code Exa 19.3** Determine the following

```
clc;
//Example 19.3
//Page No 755


//solution

```

```
//(a)

c=10*7;

disp('channel/area',c,"(a)Channel capacity = ");

//(b)

disp("(b)Splitting each macrocell");

c1=10*28

disp('channel/area',c1,"Channel capacity = ");

//(c)

disp("(c)Further splitting minicell into four
   microcells ");

c2=10*112

disp('channel/area',c2,"Channel capacity = ");
```

# Chapter 20

# Cellular Telephone Systems

**Scilab code Exa 20.1** Determine the transmit and receive carrier frequencies for AMPS channels 3 and 91

```
clc;
//Example 20.1
//Page No 768

//solution

N1=3;
N2=991;

//(a)

disp("(a)The transmit and receive carrier frequencies");

ft=((0.03*N1)+825);

disp('MHz',ft,"transmit ft = ");

fr=ft+45;

```

```
disp('MHz',fr,"receive fr = ");

//(b)

disp("(b)The transmit and receive carrier
   frequencies for channel 991 ");

Ft=((0.03*(N2-1023))+825);

disp('MHz',Ft,"transmit ft = ");

Fr=Ft+45;

disp('MHz',Fr,"receive fr = ");
```

**Scilab code Exa 20.2** Determine the transmit power for a CDMA

```
clc;
//Example 20.2
//Page No 792



//solution

Pr=-100;

disp("Substituing into equation 20-4, ");

Pt=-76-(Pr);

disp('dBm',Pt,"Pt = ")
```

# Chapter 24

# Microwave Radio Communications and System Gain

**Scilab code Exa 24.1** Determine the free space path loss in dB

```
clc;
//Example 24.1
//Page No 981



//soution

f=18*10^9;
D=16*10^3;
c=3*10^8

disp("free space path loss based on inverse square
   law, which yields, ");

lp=((4*%pi*D*f)/c)^2;

```

```
disp(lp,"Lp = ");

Lp=10*log10(lp);

disp('db',Lp,"Lp(dB) = ");
```

**Scilab code Exa 24.2** Determine the frequency of operation of the microwave link

```
clc;
//Example 24.2
//Page No 988

disp("Given: d1=18.6Km, d=14.4Km, Hn=H1=200meters, n
    =1");

//solution

d1=18.6;
d=14.4;
H1=0.2;
n=1;
c=3*10^8;

disp("From equation 24-10, the height of the nth
    fresnel zone Hn is, ");

l=(((H1^2)*d)/(n*d1*(d1-d)));

l=l*10^3;

disp('m',l," l = ")

f=(c/l);

```

```
f=f/10^6;

disp('MHz',f,"f = ");
```

**Scilab code Exa 24.3** Determine the noise power

```
clc;
//Example 24.3
//Page No 988

disp("Given: Noise bandwidth is 10MHz");

//solution

f=10*10^6;

disp("Substituting in equation 24-16 yields, ");

N=-174+(10*log10(f));

disp('dBm',N,"N = ");

disp("If the minimum C/N requirement for a receiver
   ");

Cmin=24+N;

disp('dBm',Cmin,"N = ");

disp("For a system gain of 113.35dB, it would
   require a minimum transmit carrier power(Pt) of "
   )

Pt=113.35+Cmin;

```

```
disp('dBm',Pt,"N = ");
```

**Scilab code Exa 24.4** Determine the minimum receive carrier power and the minimum transmit power

```
clc;
//Example 24.4
//Page No 990

disp("Given: Refer to figure");

//solution

disp("To achieve a S/N ratio of 32dB out of the FM
    demodulator, an input C/N of 15dB is required.
    Solving the receiver input carrier to noise
    ratios give, ");

Cmin=15+6.5

disp('dB',Cmin,"Cmin/N = ");

cmin=Cmin+(-104);

disp('dBm',cmin,"Cmin = ");

Pt=112+cmin;

disp('dBm',Pt,"Pt = ");
```

**Scilab code Exa 24.5** Determine the following

```
clc;
```

```
//Example 24.5
//Page No 990

disp("Given: The system is shown in figure.");

//solution

cn=23;
NF=4.42;
B=68;

disp("The minimum C/N at the input to the FM
    receiver is 23dB, ");

cmin=cn+NF;

disp('dB',cmin,"CMin/N = ");

disp("Substituting into equation 24-16 yields, ");

N=-174+B;

disp('dBm',N,"N = ");

Cmin=cmin+N;

disp('dBm',Cmin,"Cmin = ");

disp("Substituting into equation 24-14 yields, ");

Fm=((30*log10(50))+10*(log10(6*0.25*0.125*8))-(10*
    log10(1-0.99999))-70);

disp('dB',Fm,"Fm = ");

disp("Substituting into equation 24-8 yields, ");

Lp=92.4+(20*log10(8))+(20*log10(50));
```

```

disp('dB',Lp,"Lp = ");

disp("            At=Ar= 37.8 dB","            Lf = 4.875","            Lb = 4 dB","From Table 24-3");
```

# Chapter 25

# Satellite Communication

**Scilab code Exa 25.2** Determine the energy per bit for a transmission rate of 50Mbps

```
clc;
//Example 25.2
//Page No 1018



//solution

Pt=1000;
fb=50*10^6;

Tb=(1/fb);

disp('s',Tb*10^1,"Tb = ");

Eb=Pt*Tb;

disp('J',Eb,"Eb = ");

disp("Expressed as a log with 1 Joule as the
```

```
reference, ");

eb=10*log10(Eb);

disp('dBJ',eb,"Eb = ")

disp("It is common to express Pt in dBW and Eb in dBW/bps. Thus, ");

pt=10*log10(Pt);

disp('dBW',pt,"Pt = ");

disp('dBW/bps',round(eb),"Eb = ");
```

**Scilab code Exa 25.5** Determine the noise density and equivalent noise temperature

```
clc;
//Example 25.5
//Page No 1022



//solution:

B=10*10^6;
N=276*10^-16;
K=1.38*10^-23;

disp("Substituting into equation 25-12, we have");

N0=(N/B);

disp('W/Hz',N0,"N0 = ");
```

```
n0=10*log10(N0);

disp('dBW/Hz',n0,"N0 = ");

disp("Rearranging equation 25-12 and solving we get,
    ");

Te=(N0/K);

disp('K/cycle',Te,"Te = ");
```