RF Design Final Spring 2003

Name: _____

Student Number: _____

Do NOT begin until told to do so
Make sure that you have all pages before starting
Open notes
DO ALL WORK ON THE SPACE GIVEN
Do NOT use the back of the pages, do NOT turn in extra sheets of work/paper
Multiple-choice and true/false answers should be within 5% of correct value
Show all work, even for multiple choice

ACADEMIC INTEGRITY:
Students have the responsibility to know and observe the requirements of The UNCC Code of Student Academic Integrity (1999-2001 Catalog page 375). This code forbids cheating, fabrication or falsification of information, multiple submission of academic work, plagiarism, abuse of academic materials, and complicity in academic dishonesty.

Unless otherwise noted:

$F\{\}$ denotes Fourier transform
$F^{-1}\{\}$ denotes inverse Fourier transform
ω denotes frequency in rad/s
$*$ denotes linear convolution
$x^*(t)$ denotes the conjugate of $x(t)$

Useful constants, etc:

$e \approx 2.72$
$1/e \approx 0.37$
$\sqrt{3} \approx 1.73$
$\sqrt{7} \approx 2.64$
$\ln(2) \approx 0.69$
$\log_{10}(2) \approx 0.30$
$\log_{10}(10) \approx 1.0$
$\log_{10}(e) \approx 0.43$

$\pi \approx 3.14$
$\sqrt{2} \approx 1.41$
$\sqrt{5} \approx 2.22$
$\sqrt{10} \approx 3.16$
$\ln(4) \approx 1.38$ &
$\log_{10}(3) \approx 0.48$ &
$\log_{10}(0.1) \approx -1$
$\cos(\pi / 4) \approx 0.71$

$\cos(A) \cos (B) = 0.5 \cos(A - B) + 0.5 \cos(A + B)$
$e^{j\theta} = \cos(\theta) + j \sin(\theta)$

5 Points each

1. The wavelength in free space at 100 MHz is

   a) 3 m b) 6 m c) 33 cm d) none above

2. A voltage of 0 dBV in a 100 ohm system is equivalent to

   a) -20 dBm b) 0 dBm c) 12 dBm d) none above

3. The impedance of a 50 ohm, 1/4 λ length, transmission line terminated by a short circuit is

   a) –j 25 Ω b) j 50 Ω c) ∞ Ω d) none above

4. The angle of the reflection coefficient, Γ, of a 50 Ω inductor in a Z_0=50 Ω system is

   a) 0° b) 90° c) 180° d) none above

5. The 1 dB output compression point (P1dB) of an amplifier is usually less than the third order output intercept point (OIP3).

   a) True b) False

5 Points each

6. The noise figure of a 3 dB attenuator is

   a) -3 dB b) 0 dB c) 3 dB d) none above

7. Image rejection is most often established by the IF filter of a radio.

   a) True b) False

8. The IF filter most often sets receiver selectivity.

   a) True b) False

9. In a downconverter the IF frequency is lower than the RF frequency.

   a) True b) False

10. The preselector bandwidth most often establishes the receiver bandwidth.

    a) True b) False

5 Points each

11. A single-conversion receiver has an LO frequency of 100 MHz, an IF frequency of 10 MHz and high-side injection. The desired RF frequency of the receiver is:

    a) 90 MHz b) 100 MHz c) 110 MHz d) none above

12. A single-conversion receiver has a desired RF frequency of 100 MHz with an LO frequency of 110 MHz. The image frequency of the receiver is:

    a) 90 MHz b) 100 MHz c) 110 MHz d) none above

13. A single-conversion receiver has an IF frequency of 20 MHz, desired RF frequency band of 90-100 MHz with high-side injection. The receiver LO frequency is:

    a) 90-100 MHz b) 70-110 MHz c) 110-120 MHz d) none above

14. An FM receiver does not need AGC.

    a) True b) False

15. The beamwidth of an antenna becomes wider as the antenna gain increases.

    a) True b) False

5 Points each

16. The impedance of a 2 mm wide microstrip line on a printed circuit board of thickness 1 mm and dielectric constant $\varepsilon_r = 4$ is (to within 5%)

a) 36 Ω b) 50 Ω c) 74 Ω d) none above

17. The effective dielectric constant of a 1 mm wide microstrip line on a printed circuit board of thickness 2 mm and dielectric constant $\varepsilon_r = 4$ is (to within 5%)

a) 2.8 b) 3.2 c) 4 d) none above

18. The output noise power of a receiver with 70 dB gain, 14 dB noise figure, 10 MHz preselector bandwidth, and 1 MHz IF bandwidth is

a) -30 dBm b) -104 dBm c) -90 dBm d) none above

19. The effective (or equivalent) input noise power of a receiver with 70 dB gain, 10 dB noise figure, and 0 dBm output noise power is

a) -70 dBm b) -84 dBm c) 70 dBm d) none above

20. The spur-free dynamic range of a receiver with 70 dB gain, 14 dB noise figure, 10 MHz preselector bandwidth, 30 dBm output third order intercept, and 1 MHz IF bandwidth is

a) 40 dB b) 60 dB c) 70 dB d) none above

5 Points each

21. The gain of a dipole antenna is (to within 0.5 dB)

    a) 0 dBi b) 2 dBi c) 6 dBi d) none above

22. The free-space loss between two 3 dBi antennas at 100MHz and separation of 10 km is (to within 2 dB)

    a) 87 dB b) 72 dB c) 60 dB d) none above

23. In an urban environment, signal power between antennas can decrease by as much as 12 dB with each doubling in antenna separation.

    a) True b) False

24. A 180 degree hybrid is used in a feedforward amplifier to cancel even order distortion .

    a) True b) False

25. A branch line coupler is a form of a 90 degree hybrid.

    a) True b) False

Points each

26. A circulator can be used to redirect reflected waves caused by a poor impedance match.

    a) True b) False

27. A directional coupler can be used to measure reflected waves in a transmission line.

    a) True b) False

28. A 31-stage ring oscillator with propagation delay of 1 ns would oscillate at a frequency of:

    a) 32 MHz b) 31 GHz c) 16 MHz d) none above

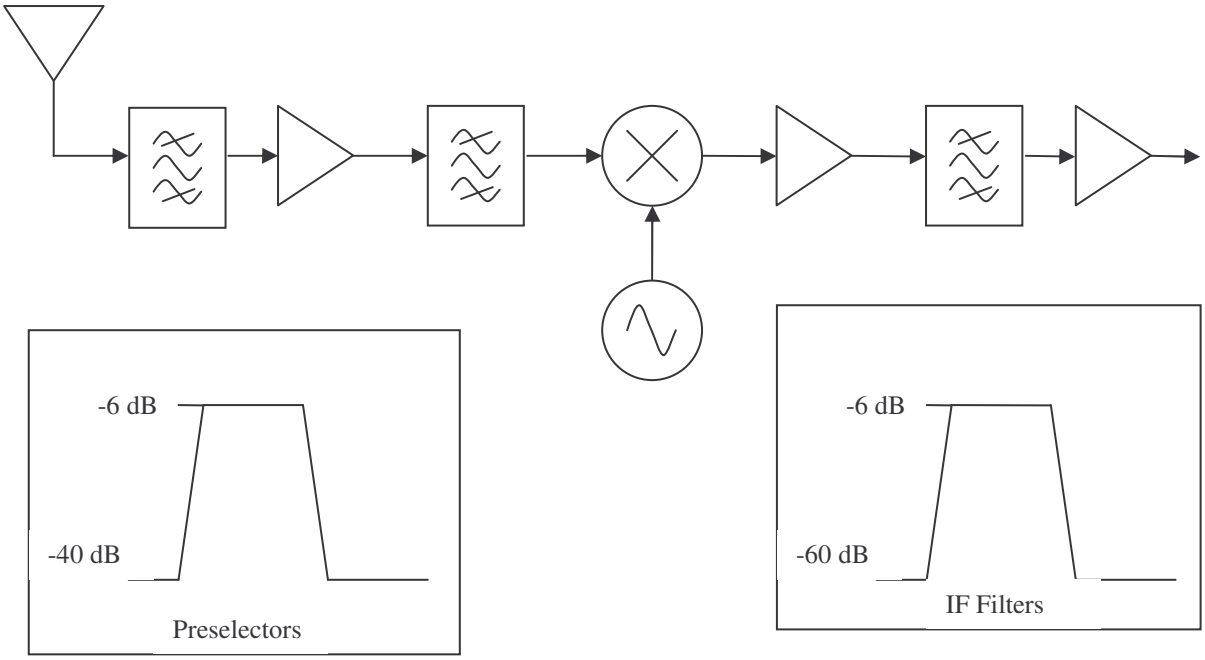
29. The sensitivity of a receiver, assuming 20 dB S/N is required, with 70 dB gain, 14 dB noise figure, 30 dBm output third order intercept, and 1 MHz IF bandwidth is

    a) -70 dBm b) -80 dBm c) -90 dBm d) none above

30. For an amplifier with third order output intercept of 10 dBm, when the two-tone output power level is 0 dBm, the power level of the third-order distortion products at the output is

    a) -30 dBm b) -20 dBm c) -10 dBm d) none above

5 Points each



31. The image rejection of the above receiver is most likely

a) 40 dB b) 68 dB c) 80 dB d) none above

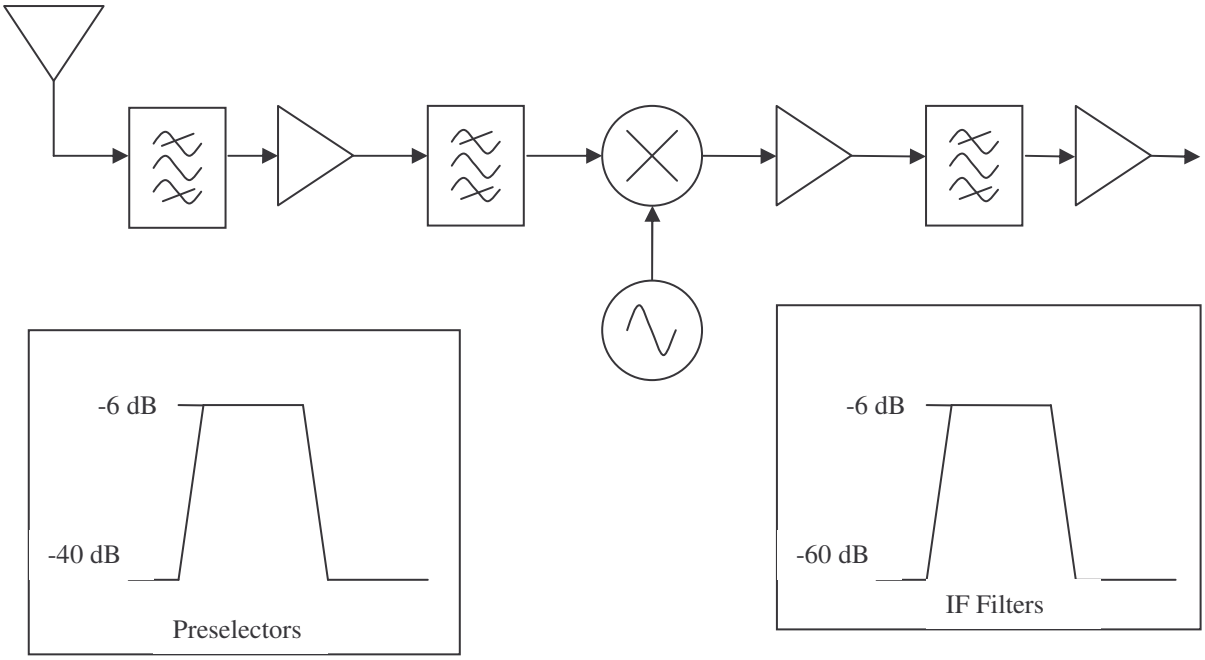
32. The selectivity of the above receiver is most likely

a) 34 dB b) 54 dB c) 60 dB d) none above

33. The noise figure of the above receiver could possibly be 4 dB.

a) True b) False

5 Points each



34. If the receive frequency range of the above receiver is 100 to 110 MHz, and the IF frequency was 20 MHz, the LO frequency would be

    a) 70-80 MHz b) 120-130 MHz c) 130–140 MHz d) none above

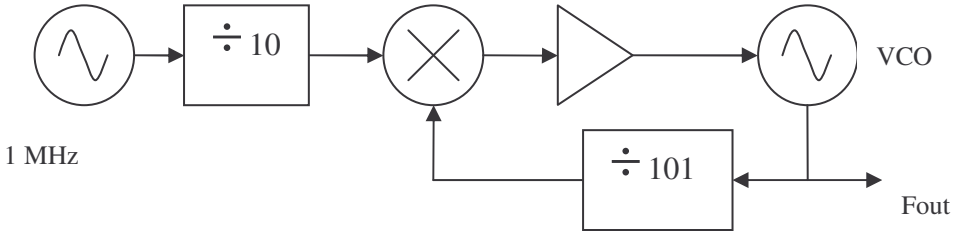
35. If the receive frequency of the above receiver was 100 MHz, and the LO frequency was 120 MHz and the IF was 20 MHz, the image frequency would be

    a) 80 MHz b) 140 MHz c) 220 MHz d) none above

36. The second preselector eliminates image noise problems.

    a) True b) False

5 Points each



x

37. The above phase lock loop frequency synthesizer is a type 1 loop.

a) True b) False

38. The output frequency is

a) 10.1 MHz b) 1.01 MHz c) 100 MHz d) none above

39. The frequency step size for the above frequency synthesizer is

a) 0.1 MHz b) 1 Mhz c) 1.01 MHz d) none above

40. In a simple 1st order loop with no frequency dividers, if K_D=1 V/rad , Ko=10^6 rad/s/V , and amplifier gain of 20 dB, the closed loop bandwidth (φ_{out} / φ_{in}) is

a) 10^4 rad/s b) 10^7 rad/s c) 10^9 rad/s d) none above